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[1] A few passages in the dissertation build on two previous publications (Pedersen, 2010; 2012). Further, parts of chapter 5 have - after the chapter had been written - been published in Pedersen and Steffensen (2014).
Due to technical problems beyond my responsibility, I lost access to the recordings at the final stage of the project. As a result of these technical issues, there are a few situations, where I have not been able to indicate time-codes in the analyses.

THE COGNITIVE ECOLOGY OF HUMAN ERRORS IN EMERGENCY MEDICINE

- an interactivity-based approach

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To my mother and father

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Preface

The overarching motivation behind this project on interactivity and human errors in emergency medicine was nourished by an interest in the multiple dynamics of human cognition in emergency medicine. The main challenge is to account for how multiple timescales affect local cognition, both at a theoretical and practical level. I have been puzzling over such perplexities within this field for some years now and I hope that this dissertation reflects the outcome of this puzzling in a meaningful way at a practical, theoretical and methodological level. I am hugely indebted to the fields of distributed cognition, distributed language and interactivity. My work builds on and extends these traditions further. However, the puzzling is still ongoing. And it awakens all sorts of emotions. I can hardly express the long days I spent in the ward, struggling to understand how non-local dynamics existed in local decision-making and shaped this decisions-making; the engagement with colleagues and friends; the joy of small gains; the fear of finding banalities; the hope for small revolutions, and the profound disappointment when the revolutions failed to occur.

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Above all, there is my family. They have been my private emergency room in so many caring ways. For instance, by showing no mercy in making sure I got this job done. I will not spell out in great detail what they already know, but let me finally say to the men in my life - Martin, Victor and Luca Bro Trasmundi - *Grazie*. It is the best word that comes to mind.

1. Human errors in the social practice of emergency medicine: an introduction

1.1 Introduction

This dissertation investigates human errors related to interaction in the social practice of emergency medicine. This first chapter situates the project in the context of society, with a specific focus on debates that have shaped the literature on human errors in complex medical settings. It presents the argument that there is a missing link between what happens in real-life settings and the findings provided by research so far. Further, it establishes the importance of investigating human error, beginning with a historical discussion of conventional work on this topic. Emphasis is placed on a change in perspective within research on human errors, identified as a shift from a person model to a system model (Reason, 2008). Traditionally, investigations have involved studies of how communicative or cognitive elements affect the emergence of errors in decision-making, problem-solving and information transmitting processes. Stress is placed on how state of the art approaches expand the object of investigation (from individuals to a system) but continue to segregate cognitive traits from interactive aspects of human error. An analysis of the shortcomings of such a segregated view of human error leads to the chapter's working hypothesis: that conventional conceptualisations of human error in the social practice of emergency medicine are flawed and lead to inconsistent findings. The incommensurability exists on a practical, theoretical and methodological level, and it is argued that an ecological perspective on human error is needed to bridge the divide between how errors are experienced in practice and how they are methodologically investigated and theoretically explained. Thus, this chapter presents an ecological account of human error and recommends investigating *error cycles* on multiple timescales. An ecological approach links human error, interaction and cognition by turning to how practitioners coordinate *in situ* as they draw on experience, knowledge and material affordances (Gibson, 1979/86). Consequently, errors are viewed as systemic and multi-

scalar in a way that links history, expertise and cultural knowledge with real-time interaction. On these grounds, the chapter puts forward the project's aim and research questions. Finally, the structure of the dissertation is presented.

1.2 Background: *Errare humanum est?*

In the Western world, approximately 70% of all human error in healthcare is related to lack of coordination and communication (Amalberti, 2013; Kohn et al., 2000). Intriguingly, most of these errors have proved to be avoidable but at the same time difficult to grasp (Leape et al, 1993).

> Even more disturbing, communication failures are the leading root cause of the sentinel events reported to the Joint Commission […] specifically, the Joint Commission cites communication failures as the leading root cause for medication errors, delays in treatment, and wrong-site surgeries, as well as the second most frequently cited root cause for operative and postoperative events and fatal falls. (O'Daniel and Rosenstein, 2008:271)

According to Eisenberg et al. (2007), the most difficult task for hospitals is to improve communication processes (Eisenberg et al, 2007:391). Eisenberg et al. (2007) report that medical errors are ubiquitous, and many of these errors are linked to communication failures (Eisenberg et al, 2007). Furthermore, it is argued that there is a "need for research about communication and information sharing among healthcare providers" (Nemeth et al., 2004:726).

The level of human error is alarming, and healthcare is under massive pressure from many sides. First, technological and sociological development increases both workload and complexity, which, in turn, raises the risk of human error. Second, public expectations of healthcare are increasing while tolerance of errors is diminishing (Reason, 1995; Horsky et al, 2005). As a consequence of this pressure, multiple initiatives have been implemented in order to streamline and control decision-making in healthcare. Many of such initiatives are based on quantitative studies that presuppose that errors are grounded in error-prone individuals who need fixed operational procedures to scaffold cognitive processing:

> We have seen an expansion of intervention studies to design, implement, and evaluate either an interprofessional checklist or clinical guidelines or protocols […] linked to a specific clinical issue […] A key limitation of these outcome-based often retrospective, quantitative studies is that we know little about the processes whereby interventions work or fail, and little about the way culture or context shapes practices, constraining or facilitating interprofessional collaboration. (Paradis et al, 2014:235)

Given the need for qualitative research, a reduction of negative outcomes is not achieved by adding even more procedures into the work practice. According to Leape: "The most fundamental change that will be needed if hospitals are to make meaningful progress in error reduction is a cultural one" (Leape, 1994: 1857). Leape (1994) argues that an error-intolerant culture has emerged in healthcare institutions. He describes the consequences of

socialising doctors in a medical educational system that has an immense focus on perfection: society, media and healthcare institutions expect that a good doctor is a doctor who makes no mistakes (Leape, 1994). The individual has been viewed as a peril and a distinct system component whose wrong choices lead to disastrous breakdowns, primarily due to a lack of attention, unsafe acts or ignorance (Reason, 2008:3). Leape furthermore holds that such an error-free ideology affects sense-making processes and attitudes in real-life treatment situations, as the fear of making mistakes actually leads to an error prone practice. Expectations of an omnipotent healthcare practitioner naturally affect how healthcare practitioners perceive themselves. Thus, according to Leape (1994), the organising principle should be turned around so practitioners are acknowledged as caring individuals working in complex and dynamical systems. Based on this view, healthcare professionals are not insensitive rule-following creatures that operate in a vacuum (Madsen, 2014). According to Leape, amongst others, it is only when healthcare institutions, the media and society acknowledge that doctors are not just rational but also moral beings, emotionally attached to what they do together with team members and patients, that errors can be investigated, understood and reduced in a fruitful way (Leape, 1994; Reason, 2000; Kohn et al., 2000; Pedersen, 2010; 2012). In other words, a positive and tolerant approach to making mistakes in medicine is crucial. Recent evidence from neuroscientific studies supports this line of argumentation (Moser et al., 2011). Specifically, it reveals how individuals with a positive, flexible approach towards learning and intelligence are less prone to repeating mistakes than those with a negative, fixed view on learning and intelligence (Moser et al, 2011). If intelligence is treated as malleable and is developed through engagement then mistakes and errors are seen as opportunities to learn and improve rather than as shortcomings (cf. Moser et al., 2011; Mangels et al., 2006). When practitioners' attitudes towards performance are a decisive factor in how well they bounce back from errors, this will in turn naturally give an indication of how errors will be dealt with in future incidents. The attitude of a practitioner is not solely a phenomenon inherent in the individual; culture and norms affect how professionals deal with error. Leape encourages healthcare institutions to acknowledge this and to nourish the education of practitioners in a way that deals with errors in a realistic manner rather than denying their existence.

Such insights are valuable and provide an understanding of the working conditions for all parties at a general level. However, it does not fully explain what happens in the local encounter when culture is re-enacted and shaped. For healthcare institutions to be able to enhance practice they need better explanations and more specific advice than general statements such as Leape's broad recommendation to start with cultural change. What does it mean to change a culture? How does one systematically generate cultural changes in a socio-technical system? To characterise the mechanisms of cultural changes, one needs to explore the enabling conditions of medical sense-making in great detail. This means that explanations of why healthcare professionals act the way they do are a prerequisite for efficient and capable intervention. What do practitioners see, feel, think, do and say? How do they manage decision-making? How do they avoid getting overwhelmed? What exactly

prompts them to break or follow a rule? How are sociocultural norms enacted through bodies in action? In other words, how are cultural accounts grounded in real-life situations and how are they investigated through concrete video-data of local interaction?

A widespread problem exists in the field of healthcare concerning how we conceptualise human errors in interaction. The field of human error is titanic. In the following sections I briefly define the classical view on human error within cognitive psychology, leading to the argument that a broader perspective on human error is needed and that such redefinition changes the object of study remarkably.

1.3 Two models of human error

When one seeks to understand human error, ontological, epistemological and methodological questions come to the fore. Explanations vary depending on the perspective one has on human error. Thus, a definition of human error is needed. The following definition is based on recent literature about human error and particularly on James Reason's book *The Human Contribution* (Reason, 2008), which builds on his previous books *Human Error* (1990) and *Managing the Risks of Organizational Accidents* (1997). Reason, a psychologist, is one of the most quoted authors within the field of human error in medical settings. In the introductory part of his book, he admits that defining error is a challenging task: "Although there is no one universally agreed definition of error, most people accept that it involves some kind of deviation" (Reason, 2008: 29). In a similar vein Sandars and Esmail (2003), in an attempt to understand the diversity of definitions across studies, report in a review on the frequency and nature of medical error in primary care that "there are a wide variety of definitions and methods used to identify the frequency and nature of medical error" (Sandars and Esmail, 2003: 231). Reason links his preliminary categorical challenge to how taxonomies are shaped to fulfil specific purposes:

> Just as there are several possible definitions, so there are also many ways in which errors may be classified. Different taxonomies serve different purposes. These depend upon which of the four basic elements of an error – the intention, the action, the outcome and the context – is of greatest interest or has most practical utility. (Reason, 2008:29)

The division of errors into four elements serves as a functional heuristic that allows investigations of one error domain at a given time. As such, it gives rise to detailed descriptions of the multiple aspects involved in the emergence of an error from its starting point in an error cycle to its negative outcome.

Notwithstanding the many different definitions of error and error taxonomies, the literature has been divided into two main positions that ascribe causality of human errors to very different sources. The two positions are denoted as the *person model* and the *system model* respectively (Reason, 2000; 2008). It is argued below that each position conveys a specific model of causality and an underlying understanding of the nature of human error that brings forth very different explanations and philosophies of error management (Reason, 2000; 2008). Challenges concerning the localisation of error in space-time

remain, and these will be discussed further in section 1.4 after the presentation of the two models.

1.3.1 The person model

According to Reason, the person model of human error originates from the occupational health and safety approach to industrial accidents, "but it is also deeply rooted in folk psychology" (Reason, 2008:71). This approach focuses on specific occurrences and, when errors occur, blames individuals for either moral weakness or lack of attention as a result of aberrant mental processes. On its own, Reason suggests, a person approach can only deal with symptoms: "Instead of dwelling upon the last accident and trying to find local fixes for what was probably a unique occurrence, the attention of safety managers is now directed towards eliminating the worst of the current latent problems" (Reason, 2005:60). In this view, individuals have been viewed as free agents who independently choose what to do and what not to do, or simply choose between safe and unsafe modes of behaviour. Unsafe acts are traced back to individual forgetfulness, inadequate knowledge, lack of skills, inattention, etc. (Reason, 2008:72). As a consequence, when errors are traced back to how individuals make decisions, blame is placed on independent individuals without considering how organisational and cultural aspects of an operation affect decision-making. As a self-perpetuating force, a blame culture is maintained by its own inherent logic of linear causality. This logic is also fed by public expectations of infallibility, which emerge in parallel to doctors' abilities to extend the boundaries of what is possibly as medical technology advances. When seeking to minimise error prone practices through the person model, individual cognitive scaffolding is targeted. Consequently, reward and punishment mechanisms are used to prompt individuals to perform flawlessly. While the approach reflects the expectations coming from society, politicians, etc., it explains errors as linear sequences of incidents related to a single timescale and location. It overlooks how errors emerge as people orient to past events and anticipate what comes next "on the basis of individual and collective intentions, aspirations and expectations" (Steffensen and Pedersen, 2014: 86). As Leape emphasises, the medical culture is mired in an error-free ideology that affects how decisions are made in local situations. This culture stems from the consumer relation between healthcare services and the public, because medical experts are viewed as omnipotent and according to Reason, it entails an urge to place blame on individuals when errors occur (Reason, 1997; 2000; 2005; 2008; Merry and Smith, 2001).

However, since errors have multiple causes, it is misguided to blame individuals or groups in the medical sector, as is often done in public media. In short, "the problem is not bad people in health care – it is that good people are working in bad systems that need to be made safer" (Kohn et al., 2000:49). The literature acknowledges that doctors are neither failure prone nor arrogant, but rather educated in a tradition and operating in a system that predisposes them to behave and use skills that may not fit current requirements. So why do we blame them? Reason proposes several reasons for blaming individuals for specific human errors. He points out that a person or team at 'the sharp end' or 'in the loop' is

closest to the error in time and space. Psychologically, we often react by ascribing causal efficacy to the entity closest in time and space to the effect; when the doctor is closest to the error (as bad outcome), he or she is seen as the 'last' and most visible defence layer (Reason, 2000). To track the error to its organisational roots is difficult (Reason, 2008) and "blaming individuals is emotionally more satisfying than targeting institutions" (Reason, 2000: 768).

Reason has successfully argued that to embrace the complexity of human errors, one needs to address the issue of how and when blame is to be placed on specific individuals (Reason, 2005, Merry and Smith, 2001). He argues that the person model, as it looks at single individuals in a vacuum, is only able to contain information about error as output and not about its complex root system running beyond individual action. Finally, the person approach might not just be incomplete, but simply flawed, as its reductionist outlook breaks down a failure into smaller and smaller parts until the elements of error are simple and localised. But, according to Reason, this operation motivated the comparison of the Canadian-invented CANDU reactor with the Chernobyl RBMK reactor, where the defence features were reduced to small elements that were "compared on a one-to-one basis" (Reason, 2008:84). Chapman (2004) addresses the crucial point that this comparative endeavour misses:

> What if essential features of the entity are embedded not in the components but in their interconnectedness? What if its complexity arises from the ways in which its components actually relate to and interact with one another? The very act of simplifying by sub-division loses the interconnections and therefore cannot tackle this aspect of complexity. (Chapman, 2004:35)

Reason thus argues for a systemic perspective that incorporates the complexity that the person model misses.

1.3.2 The system model

To get beyond the error frontline, Reason proposes a new error model that enables the identification of what he defines as *error traps* to explain how errors draw on latent conditions (Reason, 2000). The Swiss cheese model visualises how an error emerges when holes in multiple defence layers align with particular latent conditions and active failures (Reason, 2008: 101).

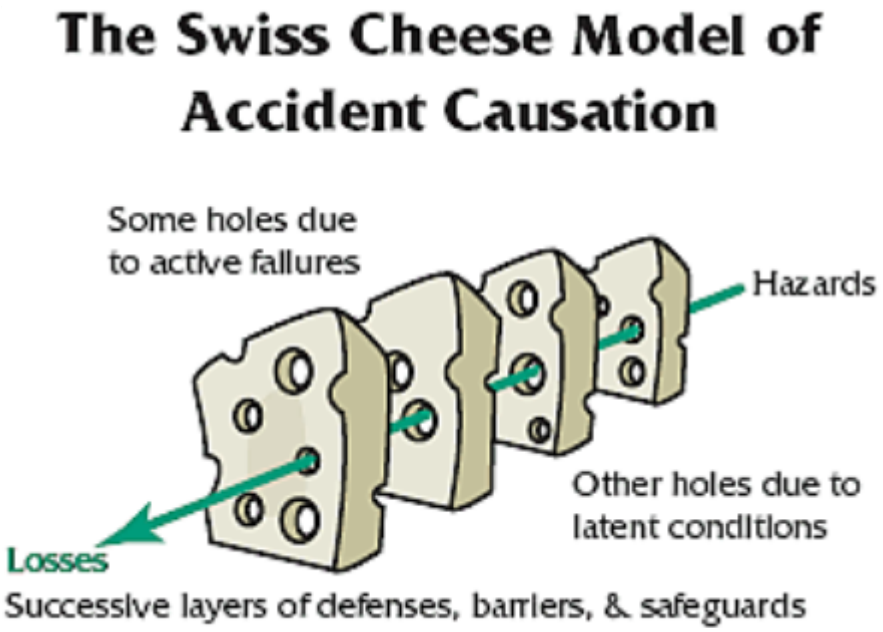


Figure 1.1: The Swiss cheese model of how defences, barriers, and safeguards may be penetrated by an accident trajectory (Reason, 2008).

While the person model recognises errors as failure output, the system model emphasises how failure emerges in a process of momentary alignment. Failure happens as a hazard passes through the trajectory of accident opportunity (Reason, 2008). Reason's model, thus, traces errors to multiple causes that are connected on several levels. From this perspective, errors should be investigated at the levels of person, team, task, workplace and institution. He emphasises that modern healthcare exploits high technology systems and procedures whose defensive layers are designed to protect patients from human errors. While some of the layers are engineered (alarms, automatic shutdowns, patient surveillance technology, etc.), others depend on procedures (regularly performed checks, administrative controls, etc.), and yet others rely on people in their formal roles (surgeons, control room operators, etc.). Unlike an actual Emmental, the cheese layers in the model are continually working, breaking down and shifting location, so the holes are constantly moving from place to place (Reason, 2008). One ineffective defence layer rarely causes human errors; errors are rather conditioned by several ineffective defence layers that bring off negative outcomes (Reason, 2005, Reason, 2008). The model, however, is rather deterministic in that it places practitioners within a system without allowing them to either affect how it works or act against the system's logic. If this were to occur, there would have to be bidirectional relations. However, Reason has recently added a slice of cheddar at the left of the model to symbolise coping resources that might recover the critical event even after many defence layers are already penetrated. Thus, recovery abilities are

symbolised by a cheddar slice without holes that serves as a negative feedback mechanism[2] blocking the critical event trajectory (Reason, 2008).

The model builds on a "new view" of human error (Dekker, 2002), which (*a*) treats error as a symptom of deep and complex conditions within the system, (*b*) believes that safety is not an inherent system condition but something practitioners must create within the system, and (*c*) links errors with how tools are used, how tasks are achieved and what the environment affords. Progress on safety systems only emerges as the understanding of multi-causality and interconnectedness of system mechanisms increase (Dekker, 2002; Shappell and Wiegmann, 2001). This new view contrasts with the old view, which considers that the system is safe and that only people are unreliable, and that automatisation, training and discipline are the means for protecting the system (Dekker, 2002). The system approach on the other hand treats human errors as inevitable yet also manageable, and individuals are viewed as resources rather than as latent, dysfunctional components.

Instead of placing people within a flow of one-way procedures, it can be recognised that there are various means of engaging and disengaging with people, procedures and equipment (Hutchins, 1995a; Hazlehurst et al., 2008). Much has been gained from focusing on the patient as 'the little person' against 'the big system'; however, there has also been a tendency to forget the well-being of the practitioner(s). Sometimes practitioners are blamed for acting as well as they can because, judged in terms of optima, this is not 'good enough.' One benefit of a system perspective is that it makes it possible to consider *both* the patient and the practitioner. The focus falls on whether, in a given environment, medical teams *can* act satisfactorily. This leads to an important insight. It is meaningless to present an analysis of a single situation without relating that analysis to a pattern on a level that illuminates cultural and organisational affordances for specific ways of acting. The problem is complex and multifaceted, and this complexity needs to be incorporated into research.

However, within the literature and in public debates, interest falls on the extent of human errors, the types of errors made and their consequences (Amalberti, 2013). As the dynamics involved in error anticipation or error prevention are often underestimated or even overlooked within the existing literature (Reason, 2008; Amalberti, 2013), Reason (2008) provides an alternative perspective: to study the human as a hero that adapts and compensates for what is lacking in a way that leads to a heroic outcome. Reason's interest falls on *the human contribution*, rather than errors (or successes) in isolation (Reason, 2008:3). Not only is the focus on errors caused by a prejudiced motivation, it is also problematic because it focuses on the one side of the story (what goes wrong). By merely looking into error processes, we only learn part of what errors are about because

[2] I use the term negative and positive feedback mechanisms for describing a cognitive system's activities that either reduce or increase complexity and eventually leads to errors, breakdowns or new solutions. For instance when frustration emerges and leads to desperate actions that continue to worsen the cognitive process, this can be explained as positive feedback within the system (Bertalanffy, 1968; Flach, 1999).

anticipatory actions that prevent errors from happening are easily overlooked. The argument presented here is: if one wants to learn about human errors, one needs to study the variety of human contributions, and not just bad outcomes. This is what this project pursues. In a similar vein, Lundberg et al. (2009) argues that the consequence of linear person approaches is related to the WYLFIWYF principle (What You Look For Is What You Find) (Lundberg et al., 2009). In line with Reason's system model, Hollnagel presents the Functional Resonance Analysis Method (FRAM), which is a tool for modelling complex socio-technical systems in healthcare (Hollnagel, 2012). It builds on the principle of functional resonance, paying attention to the functions involved in medical events and investigating outcomes as results of resonance that emerge from variability of work routines (Hollnagel, 2004). Further, Hollnagel argues that to understand human error and risk performance, one needs to investigate common functions and processes as the basis for both failures and successes. FRAM generally focuses on how functions are carried out and not just on how they fail, as established approaches tend to do (Hollnagel, 2012).

With Reason and Hollnagel as front figures, the scope of human error is expanded from dealing with individual outcome to error traps and, more recently, to human contributions in general. In line with the system perspective, the current project is not fixated on outcomes (e.g. final diagnosis); rather, it turns its attention to the positive and negative feedback mechanisms in diagnostic and treatment events in emergency medicine. According to Flach (1999), it is vital to investigate how a system adapts and coordinates as the unanticipated occurs in a way that challenges conventional actions and standard procedures. He encourages an investigation of how decisions are made when practitioners navigate across the frontier of the automatic and unknown, where conventionalised procedures become constraints for proper action. Flach (1999) suggests that under these circumstances, the agent becomes more of a problem solver than a rule follower. This flexibility allows the agent (*a*) to observe and coordinate the flow of actions and (*b*) to think creatively, allowing for boundary re-construction of the system and (*c*) to respond appropriately to the unexpected even if it means sacrificing local stability and performing on 'the edge of chaos' (Flach, 1999:125). Altogether, this new view on human errors provides a systemic perspective that involves a bidirectional focus on human successes. The new focus is, in short, on how feedback mechanisms operate in a complex environment, for good and for ill.

1.4 Critique: research incommensurability

While recognising the importance of agency beyond the individual agent, Reason - and other proponents of the system approach - remain focused on information processing in the individual, computational brain. Reason, amongst others, locates and reduces the human mind to internal cognitive schemas: "The human mind has an extraordinary ability to store the recurrences of the world in long-term memory as schemas (knowledge packages), and then to bring their products into play whenever they correspond to the current contextual calling conditions" (Reason, 2008: 18). Such a concurrent processing view is limited to

descriptions of how separate though interacting sub-systems operate in isolation with individual intentions: "All operators make errors, but the best of them have the ability to compensate for adverse effects. This ability depends on their skill and experience, as well as the extent to which they have mentally rehearsed the detection and recovery of their errors" (Reason, 2001:30). As cognition is located within single individuals, the approach leaves aside how the overall system is enabled to act as a cognitive system. Both the person approach and the system approach are inadequate for investigating what happens beyond the level of individual belief or social behaviour. At best, the person approach deals with cognitive aspects of individual human error, while the system approach investigates the social behaviour of a large, complex system.

As the investigation of communicative issues in healthcare has generally been preoccupied with the role of individuals (and individuals within systems), it is either concerned with individuals' internal cognitive skills and their functions, or individuals' communicative skills as they are used in external information exchange processes. According to this segregational view, individuals use their communicative skills to gain information that enables them to make decisions that can be right or wrong, and these two sequential processes are studied separately. Within cognitive science, the classic view of cognition (cf. Boden, 2006) as confined to individual brains has focused on internal information processing as practitioners interact with information systems and carry out predefined tasks (Kushniruk et al, 1997). For instance, extensive descriptions of situation awareness and decision-making emphasise the competences of the individual without relating them to sociocultural organisations (Fioratou et al., 2010). Regarding the conversational features in interaction, fields such as ethnography, sociology, and ethnomethodology have studied the social and interactional order in conversations (e.g. individuals' use of sequential patterns in verbal interaction), treating this as the sole explanatory framework for human interaction (e.g. Goffman, 1974; 1983; Heritage and Clayman, 2010). Thus, the theories of cognition and interaction that are embedded in the aforementioned approaches do not correspond with recent understandings of cognition and language as distributed and ecological (see chapter 3). Basically, this means that errors as they emerge and are experienced in practice do not correlate with empirical findings based on conventional approaches to human errors. This incommensurability entails a scientific gap. This dissertation hypothesises that this gap is due to a misconceived view on the nature of cognition and language, and thus also of human errors related to interaction.

Finally, both the person approach and system approach fall short of explanations that deal with errors in a multiscalar view, both in space and time. However, recent studies underline how enabling conditions of human interaction are also tied to timescales beyond the conversational level – such as, for instance, the ones tied to the bio-mechanics of living bodies (Thibault, 2011; Steffensen, 2012; 2013; Cowley, 2013; Linell, 2009; Jensen, 2014b). These impending ecological intellectual semblances challenge traditional approaches to human interaction. By opening up to deal with both faster and slower timescales than those concerned with words, human errors can be dynamically linked with history, culture and knowledge in situated interaction. The transgression of timescales is

pivotal in the study of human interaction, because culture emerges and materialises in the relationship between here-and-now and slower timescales. In what follows, an ecological understanding of human errors is presented.

1.5 An ecological approach to human error: from errors to error cycles

An ecological account of human error deals with *error cycles* consisting of (*a*) conditions for errors, (*b*) real-time occurrences and, (*c*) development due to the system's (lack of negative) feedback mechanisms. When moving from error as a local object to error cycles as a process, the ecology of errors expands local boundaries in time and space. An error cycle is characterised as dysfunctional dynamics within a cognitive system with a functional agenda. From this perspective, errors are *not* solely defined by their negative outcome, but as the process in which tensions, frustration and fixation biases can emerge. Sometimes, such processes are balanced as the system adapts flexibly when changes are anticipated. Cowley describes human behaviour as flexible and adaptive, meaning that humans use: "*cognitive dynamics* to control how they coordinate the world. Humans extend this general capacity by cooperating in cultural settings. Using resources that constitute our perceived worlds, biology becomes enmeshed with history" (Cowley, 2007:1). A cognitive system's flexible adaptive behaviour can be described as an ability to change and expand its ecological niche[3] as it recalibrates its boundaries. For instance, the system flexibly adapts when a practitioner innovates, finds a new solution to a well-known problem, or when a novice doctor relies on an experienced nurse, distributing the responsibility between the parties rather than turning to individual problem-solving. As will be explicated in the analyses (chapter 5-10), coaction is a meshwork shaped by what has happened before, what the environment offers, capabilities for action and the expectations related to the joint professional project (Rączaszek-Leonardi, 2011). As such, errors are related to how practitioners interact and manage cognitive events by manipulating their environments and each other. By widening the scope of attention to include abstract information structures (Baber et al., 2006), people, relationships and material environmental structures, a more nuanced description of what actually happens and how errors are tied to multiple timescales is revealed. From this perspective, intention and thinking are not internal local processes; they are distributed (Hutchins, 1995a; Hutchins, 2014; Hollan et al, 2000) and non-local (Steffensen, 2013; Steffensen and Cowley, 2010).

Conditions for errors can be latent systemic properties and real constraints on action.

[3] From an ecosystemic perspective, niche construction describes the process of how an organism modifies its environment through its metabolism and its interactions (Laland et al, 2013). As such, a functional relation between a species and its environment is maintained in niche construction: "What human beings do together arise in a specific ecological niche (cognitive-natural-sociocultural) and feeds back into that very niche: structures and resources arise in ecologically embedded interactivity, just as they integrate into human interactivity, across time and space." (Steffensen and Fill, 2014:19)

Moreover, an ecological definition of human error necessarily deals with the mesh of multiple timescales (latent conditions, emergences, and responses) in a cognitive system. The crucial element in this definition is the coupling between the sub-systems. The coupling precludes reductionist analysis of single components in the system. The cognitive powers of the overall system emerge in interaction. Even though results are achieved as a consequence of coordinated interaction, the enabling (latent) conditions for coordination are important for the overall system operations. In a professional organisation these latent conditions relate to (*a*) individual capabilities as skills, experience, ideologies and beliefs, (*b*) the socioculturally shared norms, rules, values, experience and belief, (*c*) the physical environment and (*d*) local interaction.

Sociocultural norms and rules afford a range of behaviours that practitioners and patients use to interact in an expected way. Such expectations enable successful outcomes, but may also entail fixation biases that prevent practitioners from solving a problem and moving on. Depending on the system's capability for action, specific feedback mechanisms contribute to or constrain the error process. Thus, how a technological artefact facilitates diagnostic processes or not depends on situated action, sociocultural rules for using the device and whether it is a functional part in a given situation. As such, interaction, as the coupling energy, becomes the guiding element in analysis. This is important since patterns of behaviour can be traced to how a practitioner alters the environment. Such alteration is an interaction between historical and physical characteristics such as the level of skill, the level of knowledge information, the history of experience and local affordances for action (how the setting is organised, what is being said, which cognitive aids are visible to whom etc.), see e.g. (Goodwin, 1994; 2007). Specifically, a practitioner modifies the functional relationship between himself and his environment, or rather, he adapts to the changes in the system of which he is a part. A doctor can move around in the system, but there are constraints on actions. The cognitive ecosystem is defined by its bounded and dynamic possibilities for action (Baron and Hodges, 1992; Hodges, 2007a; 2007b; 2009). As a heuristic the constraints relate to: ontogenetic development (including personal history, level of skill, educational level, etc.), physical structures and artefacts available (electronic devices, etc.) and sociocultural norms (e.g. what is usually done by whom). An understanding of each element, as considered by the person approach, for instance, is not crucial for grasping how such constraints work. If a doctor lacks communicative expertise, an experienced nurse can compensate for this and, if a problem is solved in a functional way, might not be relevant to understanding the system. How such an interaction has contributed to situational development is the relevant starting point, directing attention to the system as a whole and beyond the components within the system. As such, some actions can be traced to cultural patterns, and others are explained as ecosystemic. But importantly, cultural explanations are not based on an outside-in perspective; rather, they are grounded in embodied actions in the situation itself. Thus, the analytical part, takes its starting point in real-time situated particularities and identifies local dynamics that can be traced to patterns beyond the local.

1.6 Overall aim and research questions

This project aims at providing detailed empirical and qualitative analysis of how interactivity connects healthcare professionals' real-time actions to social knowledge, norms and sense-making in the course of managing cognitive events. Such an investigation seeks a thorough understanding of enabling conditions for human error cycles and processes of error anticipation. Since qualitative studies of the enabling conditions for error cycles in the ward are scant, there is a need to investigate the dynamics of emergency treatments further. The main argument is that an ecological approach to error cycles, language and cognition can go beyond local instances of error management and provide a new understanding of how errors are encountered *in interaction.* Since an isolated focus on bad outcomes only explains part of the problem, an ecological interactivity-based approach is needed, if the aim is to contribute to safe and caring healthcare practices for all parties. However, as chapter 2 reveals, the methodological prerequisites for investigating error cycles related to interaction from an ecological perspective are not fully developed. Thus, the project has a dual, yet still coherent, focus that connects the methodological needs with the gap in research.

The value of thinking in terms of cognition and interaction as a multi-scalar activity will be demonstrated with respect to how they are being used in an emergency department in a Danish hospital. The project's overarching research question is:

How do healthcare practitioners manage cognitive events in patient diagnosis and treatment in a way that yields cognitive results?

I further raise three subquestions that relate to the overall research question:

(i) How do healthcare practitioners anticipate and counter errors? How does an emergency medical team function to prevent errors in complex diagnostic situations? How do errors emerge and escalate in a (dys)functional social system?

(ii) How does medical culture affect real-time interaction and how is the culture itself shaped by the exact same dynamics?

(iii) What are the methodological innovations that can be extrapolated from an ecological perspective on human errors and an ecological approach to language and cognition?

To understand how errors emerge, evolve and are prevented, one needs to investigate both positive and negative feedback mechanisms in interaction. Much depends on how people orient to patterns that endure or recur over time and space. By contrasting real-time sense-making with the meanings displayed by people in interaction, important issues that relate to the situation transcendent aspect of sense-making are exposed (Linell, 2009). Specifically, the questions above yield detailed descriptions and explanations of an outcome's enabling conditions.

The main argument triggers both practical and methodological questions, and this

complexity is reflected in the duality of the project's aim. First, and in a practical vein, the project gains a thorough understanding of what actually happens as healthcare teams diagnose and solve problems, or fail to do so. This insight has direct impact on the design of training programmes in the ward, and such interventions may lead to a safer and more caring practice for all parties involved. Second, the project also has a methodological motivation. It qualifies and develops existing methods to human interaction in general, which consequently enriches the design of empirical research projects.

1.7 Structure of the dissertation

The dissertation is divided into 11 chapters. This first chapter presented the argument that there is a missing link between what happens in real-life settings and the findings provided by research so far. Chapter 2 refines the argument presented in chapter 1 by reviewing dominant positions and approaches in the field of human interaction and cognition in healthcare settings and comparing them to the relevant findings provided so far. The project's specific approach is defined by contrasting it to, on the one hand, conversation analytical approaches to social interaction, and, on the other, to a classic approach to the study of distributed cognition.

Chapter 3 introduces an analytical framework of human interactivity. Given that the multi-scalarity of interaction is not reducible to dynamical coordination at only one local timescale, the presentation of an interactivity-based framework allows for investigations of the ecology of human cognition. To track the dynamics linked to various timescales, the framework uses theoretical concepts and approaches from conversation analysis (Sacks et al., 1974), distributed cognition (Hutchins, 1995a; 2014; Kirsh, 2006; 2009; 2013; Hollan et al., 2000), distributed language (Cowley, 2005; 2007; 2009; 2010; 2011; Thibault, 2011; Love; 2004), dialogism (Linell, 2009), Cognitive Event Analysis (Steffensen, 2013; Steffensen et al. forth.) values realisation theory (Hodges and Baron, 1992; Hodges, 2007a; 2007b; 2009) and ecological theories of visual perception (Gibson, 1979/86; Noë; 2004). Rather than taking recourse to models of likely performance by agents in predictable settings, the interactivity-based framework complements standard organisational, psychological and medical models with a humanistic approach to how people actually deal with unpredictability, risk, high information load, and frequent interruptions without being fixated at only one timescale.

Chapter 4 discusses the methodological prerequisites for performing detailed qualitative analyses of human interaction within the interactivity-based framework. Methodologically, the project uses a non-experimental design to investigate the core features in medical interaction. Empirical work is based on the use of video ethnography at the Department of emergency medicine at Køge Hospital. As cognitive ethnographic fieldwork, the project combines methods ranging from research that links video-observation with qualitative interviews and participant observation on how material culture influences interaction. Given this constellation of methods, the research design presented allows for a focus that can span both micro and macro scales of medical interaction. It presents the empirical

work that has been carried out in real-life settings as well as the methodological, practical and ethical concerns that have been raised prior to and during the investigation. Based on an initial coding process, six themes were defined and further investigated as organising principles of the interactions in the following analysis.

The analysis covers the main contribution of this project. It consists of 6 chapters (chapter 5-10). These chapters provide a fine-grained investigation of interactivity in the emergency ward. The main findings are based on analyses of how interaction in a medical team links agents, artefacts and expertise. This analysis balances between (potential) medical error cycles and, more generally, how practitioners undertake treatment as a team-based problem-solving activity. The analytic focus is on (*a*) medical visual systems; (*b*) interruptions; (*c*) diagnostic procedures (e.g. anamnesis and patient examination); (*d*) medical cultural dynamics; (*e*) sense-making teams and (*f*) writing the electronic medical record. The analysis demonstrates how team members enact expertise-in-action, and also how lack of coordination and communication can lead to human errors. In particular, it shows that non-routine events are crucial to what goes on in the emergency ward: anomalous events function as affordances and trigger feedback mechanisms which prompt team members to anticipate possible changes of plans. For instance, it will be demonstrated that interruptions are handled differently depending on the interlocutors' level of expertise, team constellation and situational and material circumstances.

The final chapter, chapter 11, summarises how the research question has been investigated, and implications of the project are drawn. The ambition is, through real-life examples, to demonstrate what an ecological perspective on human cognition and interaction gains. In a practical vein, project insights are used to discuss how this approach impacts the way healthcare organisations scaffold learning and education among their employees. The project will thus meet its objective of improving team interaction and treatment procedures and, by so doing, contribute to a dialogical healthcare practice that gives consistent attention to patient safety and healthy work practices. Accordingly, the value of an interactivity-based approach is demonstrated with respect to its current use in the emergency department at Køge Hospital.

Finally, the chapter explores the methodological implications of this project especially in relation to a criterion of generalisability. The dissertation makes clear that it does *not* provide a complete account of the entire ecology of human cognition, rather, it gives an ecological account of pivotal elements in (dys)functional cognition. It is argued that qualitative investigations of naturalistic medical settings provide insight about how local behavioural coordination differs due to a cognitive system's capability to recalibrate its boundaries. Such conclusions reveal how particulars matter for the understanding of the ecosystemic conditions for cognition as bounded and dynamical, and, in the end how local actions contribute to or constrain the emergence of error cycles. The chapter also discusses how the project, as an empirically grounded methodological and theoretical contribution to the field concerned with human interaction, opens up for new projects and investigations. Lastly, the prospective impact of the dissertation is mentioned. By showing the results of embedding naturalistic studies of human interactivity in an ecological framework, the

project illuminates the benefits of treating language and cognition as ecological, distributed and intertwined in interactivity. In so doing, it challenges traditional approaches in linguistics and cognitive science to adapt their methods in accord with these foundational assumptions.

2. Positions in the study of health interaction and cognition: a critical review

2.1 The landscape of social interaction: linguistic and cognitive perspectives in emergency medicine

Where chapter 1, from a broad sociopolitical perspective, discusses the necessity, relevance and importance of studying the current research question and errors in emergency medicine and interactional topics in general, this chapter reviews well-established approaches used in the study of health interaction. Chapter 1 and 2 are linked, as the need for further investigation is discussed in relation to shortcomings of existing approaches and the *type* of findings they provide. By investigating health interaction, the project opens up a discussion of how people coordinate as they diagnose and solve problems. Traditionally, interaction studies have treated interactional processes as distinct

from culture and cognitive processes. For instance, focus has been placed on what people say and how they use gestures as a means to construct identities and interpersonal relations. Additionally, focus is on how they think about and solve problems - which will be further emphasised in the review. As mentioned in chapter 1, this segregational view has led to two contrasting positions in the study of health interaction: on the one hand, various conversation analytical approaches to social interaction and, on the other, distributed and embodied approaches to cognition in healthcare settings. An underlying hypothesis of my project is shaped by the argument that existing approaches within these two perspectives do not fully explore the enabling conditions of real-time coaction and cognitive dynamics in emergency medicine. My project therefore places itself in the intersection between interaction analysis and cognitive studies of human interaction. Thus, it reviews two contrasting and *a priori* incommensurable positions.

The chapter starts by discussing the historical backgrounds of two prevalent positions to human interaction and cognition in healthcare. It considers classic texts and it examines their underlying assumptions and ideological agendas. This discussion originates from a historical exposition of how and why each specific approach has been developed. When reviewing two major positions, the chapter likewise covers a wide range of qualitative approaches and it critically discusses their underlying theoretical assumptions as well as their practical applicative values and shortcomings. Due to the project's aim of examining the enabling conditions of human interaction in naturalistic emergency settings, the review exclusively focuses on positions that are concerned with investigations of naturally occurring social interactions.

The review discusses relevant research studies and findings within the abovementioned approaches. This discussion gives a detailed indication of what *kind* of insights the various positions offer – and the shortcomings of their presupposed purposes and perspectives. Finally, the chapter provides general conclusions about controversies within and between the positions. It highlights insufficiencies in the traditional approaches to the subject under investigation. To sum up, the chapter is a synthesis that links current positions and outlines their compatibilities, differences and shortcomings. Naturally, this examination leads to a discussion of the theoretical underpinnings underlying various sets of methods. It critically asks what is needed in order to come up with comprehensive answers to this project's research question. Building on this, it moves towards an interactivity-based framework that provides alternative methods, while at the same time qualifying and developing existing analytical approaches. This framework is elaborated in chapter 3. The chapter concludes by providing a theoretical grounding of the dissertation that adopts an ecological methodology. In short, two interrelated questions are investigated in the present chapter:

- How do conversational analytic approaches and embodied/distributed cognitive approaches study health interaction?
- What *kind* of descriptions and explanations are approved in each domain and, in turn, how are they reflected in the findings provided by the two positions? What are their strengths and shortcomings respectively?

The review gives a broad overview of the literature on interaction in healthcare, generated by conversation analysis (henceforth CA) and distributed cognition (henceforth DC). It does not seek to enlist all material published, but to synthesise and evaluate relevant studies in relation to the guiding concept of my research questions: an endeavour, which is also reflected in the search strategy below. At a practical level, the review is divided into two separate parts with two distinct focuses: CA studies in healthcare and DC studies in healthcare.

As the project has a primary focus on real-time observable features of medical interaction, the review leaves aside approaches that quantify interaction through general coding tools and classification schemes, such as those offered by Interaction Process Analysis (Bale, 1950). Such methods implement a pre-defined, exhaustive classification of events in real-time interaction. In the effort to present a general overview of the medical encounter, they sacrifice details of the context, assuming there is no connection between how and why people talk and what they talk about (Charon et al, 1994). Rather than such abstracted approaches, this review considers studies that focus on the microanalysis of real-time, natural face-to-face interaction in medical encounters.

2.2 Conversation analysis: ethnomethodology and the social order of interaction

In this review, CA-based studies become the locus of interest as CA has been – and still is – the dominating approach to face-to-face interaction: "CA has grown significantly in popularity […] It has grown in influence, becoming increasingly recognized and legitimated both by researchers in a range of social science disciplines […] And it has demonstrated its vitality by continuing to expand its body of published research output" (Hutchby and Wooffitt, 2011:vii). The prevalence of CA is also identified within the domain of healthcare interaction (Collins and Britten, 2006), and Pilnick et al, (2009) add: "Over the last three decades, conversation analytic (CA) studies have illuminated some of the fundamental organisational features and interactional processes in a broad array of medical encounters. Investigations of interactions between physicians and patients have been a cornerstone of this field since the early 1980s" (Pilnick et al, 2009:787). Heritage and Maynard (2006) argue that over the last 20 years, CA "has become a substantial presence in the studies of physician-patient communication" (Heritage and Maynard, 2006:362). Chatwin (2004) states that CA "is well-established as a means of exploring the interactional detail of conventional healthcare encounters" (Chatwin, 2004:131). Finally, Collins and Britten (2006) emphasise how CA has contributed with significant advances in understanding how healthcare practices emerge in the meeting between patients and healthcare practitioners. This progress is ascribed to CA's principle of comparative analysis (Collins and Britten, 2006:46), which is a result of bringing together interrelated analytic contributions about how structure of talk is organised in various situated interactions. Although CA builds on such major traditions as ethnomethodology and interaction analysis, my focus will be on CA itself. Explanation of its roots and history will be implemented in that exposition. Before light is shed on the particular findings provided

by CA, its historical background is framed in order to locate its motivation, objectives and intellectual origins. On these grounds CA's main principles are outlined and critically discussed.

In the 1960s, the young sociologist, Harvey Sacks, literally invented CA. His colleague, Emmanuel Schegloff, and later Gail Jefferson, who further qualified and developed the approach, rapidly joined him. From 1963 onwards, Sacks conducted a project at the Suicide Prevention Center in LA (Collins and Britten, 2006), becoming the first to use CA in a medical setting – or rather, CA emanated from his observations during that project. Specifically, Sacks became intrigued by the fact that callers were unwilling to give up their names when they called the Suicide Prevention Center. He wondered where in a conversation you could decide that a caller would *not* give up his name. Sacks then scrutinised a famous opening sequence where a caller avoids giving up his name after the call taker has introduced himself. Where the caller was expected to respond with an announcement of who he was, the caller replies: "I can't hear you." The call taker then repeats his name, and the caller echoes his answer ('Smith') and closes the sequence. By doing so, the caller has moved the interaction to a next point in the conversation without explicitly refusing to give up his name (Hutchby and Wooffitt, 2011:16). With a real-life example, Sacks showed that "it was possible to analyse how, in this instance, this particular utterance performed this particular activity in this particular slot, or place in the interaction" (Wooffitt, 2005:6). This line of thinking sowed the seeds for CA, a methodology that Sacks continued to refine and disseminate to colleagues and students.

Sacks' ideas emerged from a radical research programme in the University of California, initiated by his critique of mainstream approaches to social phenomena within sociology. His lectures, given in sociology departments of the University of California Los Angeles and later UC Irvine, are characterised as original, path breaking, radical and iconoclastic (Hutchby and Wooffitt, 2011). Sacks recorded most of his lectures on tape. After his early death in 1975, Gail Jefferson edited and published Sacks' work in book form (Sacks, 1992). With respect to its historical grounding, it needs to be emphasised that CA, in its tentative beginnings, was a radical and controversial alternative to existing approaches to the study of social interaction. It has even been labelled a revolution (Heritage and Clayman 2010:8).

CA is the study of conversation, or talk-in-interaction (Hutchby and Wooffitt, 2011). The basic assumption within CA is that everyday talk is socially structured, and this structure can be analysed by focusing on the sequential organisation of talk as a turn-taking system (Sacks, 1992). The approach grew out of the ethnomethodological tradition in sociology with Harold Garfinkel (1917) as a forerunner. Garfinkel emphasised that participants are able to make joint sense due to a set of shared methods for practical reasoning (Garfinkel, 1967). Another sociologist, Erving Goffman (1922), likewise influenced Sacks' thinking: as a student of Goffman, Sacks became inspired by his studies of how ordinary events were linked to social significance. Goffman focused on how the study of verbal language was about the 'interaction order', interactional rules and structures different from the ones studied in traditional linguistic descriptions of language (Liddicoat, 2011:4). In short, CA

is an intersection of these sociological traditions:

> From Goffman, they took the notion that talk-in-interaction is a fundamental social domain that can be studied as an institutional entity in its own right. From Garfinkel came the notion that shared methods of reasoning are implicated in the production and recognition of contributions to interaction, and that these contributions advance the situation of interaction in an incremental, step-by-step fashion. (Heritage and Clayman, 2010: 12)

The idea of observable order at any level in mundane conversation was ground-breaking at its time. CA was able to describe social orderliness in real-life data – and according to Sacks himself, CA was not just the best approach, it was simply the only game in town. His belief in the exceptionalness of CA is clearly demonstrated in a recorded lecture: "there's an area called the Analysis of Conversation. It's done in various places around the world, and I invented it. […] There is no other way that conversation is being studied systematically except my way. […] It's just never been done. It's been done here for the first time" (Sacks, 1992, Vol 2:549).

As the CA research programme evolved, Schegloff and Jefferson became just as much responsible for the grounding of CA in sociological practice as Sacks (Sacks et al., 1974). Clearly, CA was adjacent to major contemporary traditions within sociology such as ethnomethodology, but Sacks explicitly pointed out that the methodologies behind those traditions are different. He argued that the majority of sociologists were barking up the wrong tree when they relied on subjective descriptions established in interview settings. Furthermore, he criticised the idea diffused amongst sociologists that most sociological phenomena were unobservable. Basically, what Sacks wanted to move away from was a sociology that overlooked the member's perspective in natural occurrences of talk. By interviewing informants, Sacks argued, one only gets categories that informants use about their own activities, so that in the end, the reader must rely on what the ethnographer chooses to present. The reader thus has to take the reliability of the outcome on trust (Hutchby and Wooffitt, 2011). With CA, Sacks provided a methodology that enabled researchers to get beyond the problem of subjective interpretation. As CA emerged as a critique of contemporary sociological practice, where subjective interpretation and trust were the underlying principles in research, the CA research programme aimed at more strict and transparent analysis, facilitated by technological apparatuses embedded in the field of natural occurring interaction. As a ground-breaking initiative, it used audio recordings of naturally occurring talk to unveil the deeply social organisation of interaction. According to the CA programme, transparency and systematic methods were prerequisites for valid and reliable research. As such, rather than starting with theory, CA started with data, and theory could only work if it was data-driven. Research processes in CA are not guided by research questions; rather, they are guided by a principle of 'unmotivated looking' (Hutchby and Wooffitt, 2011:26), which turned the sociological *modus operandi* upside down. For sociology in general, the ethnographic method did the opposite: through interviews, informants were asked about everyday issues outside the context in which they were employed. Attitudes, feelings, causes of deviance, etc. were

treated as more real and interesting than what could be observed. The analytical procedure sought to unveil what was hidden through detailed interpretation. In contrast, Sacks' scientific credo was all about observation, and this was intrinsic in his analytical approach. He underlined how scholars observationally can deal with everyday actions of social life in a way that goes beyond subjective interpretations, generalisations and experimental studies. In what follows, the main principles of CA are elaborated.

The aim of studying conversations is to investigate how members co-construct a social order by describing how sequences of interaction are produced and interpreted in terms of members' responses to previous turns. This procedure is called 'next-turn-proof-procedure' (Hutchby and Wooffitt, 2011:13). CA's unit of analysis is not reduced to one of talk, such as semantic units; rather, it includes the interactional organisation of social actions, such as negotiations, proposals, complaints, etc. (Hutchby and Wooffitt, 2011). CA became a viable (and indeed dominant) method because it provided a strong, naturalistic and evidence-based method for the study of interaction. Its unique methodological trait is its particular obligation to base analytical findings on transcribed recordings of naturally occurring data, which can be verified through transparency in data collection and analytical procedures (Hutchby and Wooffitt, 2011). Most important is the analytical focus on social orderliness from the perspective of the members of a conversational practice. This intrinsic viewpoint leads to an investigation of sequences, where a speaker displays a specific understanding of the previous turn uttered by another speaker. The analytical process thus unfolds a turn-by-turn unpacking of interaction:

> while understandings of other turns' talk are displayed to coparticipants, they are available as well to professional analysts who are thereby afforded a proof criterion (and a search procedure) for the analysis of what a turn's talk is occupied with. Since it is the parties' understandings of prior turns' talk that is relevant to their construction of next turns, it is their understandings that are wanted for analysis. The display of those understandings in the talk of subsequent turns affords … a proof procedure for professional analysis of prior turns – resources intrinsic to the data themselves. (Sacks, Schegloff and Jefferson, 1974:729)

A focus on how co-participants jointly construct the conversational order challenges traditional linguistic approaches that treat the individual as the unit of analysis. In enumerated points, important principles in CA can be outlined as follows:

1) Actions are embodied turns of utterances that are sequentially structured in a turn taking system, e.g. the sequential co-construction of question-answer patterns during a medical consultation (Collins and Britten, 2006)

2) Local turns (spoken and non-verbal) execute social actions that connect with broader actions of a conversation, e.g. the overall goal of providing a diagnosis (Collins and Britten, 2006).

3) As local utterances recur across situations, sequence patterns become

conventionalised stable patterns, e.g. the opening exchanges in a medical encounter between doctor and patient (Collins and Britten, 2006)

4) Observable sequences of units constitute a turn-taking device, which serves as an explanatory principle for social coordination/behaviour (Collins and Britten, 2006).

5) Language is situated action, rather than unobservable potential, and it must be analysed with other multimodal resources such as gaze, gestures and body movements (Mondada, 2008, Goodwin 1994; 2002; 2003; 2007, Streeck, 2009; Streeck et al., 2011).

With the possibilities provided by video-recordings arose the interest for analysing conversations as multimodal. These other aspects of interaction are important to show how participants orient to each other and to the context, the material and social aspects of the situation (Mondada, 2008). Goodwin (2000; 2007), Mondada (2008) and Streeck (2009) for instance demonstrate how pitch, gesture, gaze and movement are interdependent semiotic fields that all contribute to the meaning of specific actions. As mentioned in the beginning of this chapter, other analytical approaches have materialised parallel with CA. Multimodal interaction analysis, for instance, underlines how embodied modes of interaction, in principle, are equally important and should be implemented in analysis (Norris, 2004: xi). In applied linguistics, Goodwin, who uses video-ethnography, has showed that gesture, embodiment and the materiality of a temporal environment are all fundamental aspects of investigations of how action is built within human interaction (Goodwin, 1994; 2000; 2002; 2003; 2007; Streeck et al., 2009; Streeck, 2011).

In conclusion, CA challenged traditional linguistic studies. According to Sacks, invented examples of language for the purpose of studying their formal properties in a vacuum have little to do with how real people use language in interaction (Hutchby and Wooffitt, 2011:21). Turning toward the application of CA to healthcare settings, it is worth mentioning that CA is not restricted to specific domains such as the medical clinic; rather, it is a universal approach that works across different interaction settings: "the organization of interaction described in CA studies of ordinary conversation–for example, turn-taking (Sacks et al. 1974) and repair (Schegloff et al. 1977)–is largely carried forward from the everyday world into the doctor's office" (Heritage and Maynard, 2006:362).

2.2.1 A CA literature review: search strategy, search process and selection criteria

The search process has been narrowed down to deal with CA approaches to medical interaction. A total of 6 major databases within the field of language, psychology, sociology and medicine were searched. The databases are 1) *Academic Search Premier,* 2) *Linguistics and Language Behavior Abstracts*, 3) *Web of Science*, 4) *PubMed Medline*, 5)

Scopus and 6) *psycINFO*. The search string combination "conversation analysis" AND "healthcare" in abstracts, titles and keywords [4] generated 203 hits in total. 203 abstracts were reviewed and 60 of these articles met the inclusion criteria, which were as follows: a study uses CA on naturally occurring data (not mediated interactions, interviews or simulation, etc.); it investigates interactions between adult native speaking patients and doctors and/or nurses (interactions with surgeons, pharmacists and psychotherapists as main practitioners were excluded due to the specialisation level related to such professional roles); and finally, it excludes data where the patient is mentally ill or suffers from severe cognitive or communicative impairment (schizophrenia, aphasia, autism, brain damage, etc.) because, in such cases, the interaction process *per se* deviates from the general medical interaction baseline that this project focuses on. The data was extracted September 30th 2014, and studies that were not published in English or in a Scandinavian language were not reviewed.[5]

2.2.2 CA studies in healthcare settings: focus and findings

In this review, all articles were coded according to year of publication, recording device used (video or audio), focus and empirical findings provided. The findings and focus were comprised into 1 to 2 sentence descriptions that extracted the main contribution of a given article. Finally, comments were made on whether a study presented results based on multimodal or verbal analysis. The practical outcomes vary regarding scope, degree of detail and generalizability. The specific focus and empirical findings of each paper are highlighted in a coding scheme (see appendix A). For an example, see an excerpt of the coding in the table below:

#	Author	Audio/video	Multimodal analysis	Focus and findings: Verbal analysis
1	Aiarzaguena et al, 2013	Video	No	Doctors struggle with symptom explanations due to the complexity of describing complex biological processes. This is seen in degree of hesitation, self-interruption, repetitions and silences

Table 2.1 Review: Conversation Analysis AND healthcare

4 This project deals with interaction in an emergency department. When combining a CA search with *emergency medicine* in these databases very few hits appear, hence the review deals with healthcare interactions at a broader level. This is underlined further in the inclusion criteria below.

5 In practice, this only meant that two articles, one in Finnish and one in German, were discarded by these criteria.

2.2.2.1 Interaction order

Common to all contributions is the focus on how verbal conversation involves the importation of social orderliness or of the interaction order (Goffman, 1983). The orderly character within all interactions relates to how participants jointly construct, protect and exploit identities and roles in sequential interactions. For instance, Ariss (2009) discusses how asymmetries of power in medical encounters are related to how the participants display normative entitlements to knowledge that relates to their identities in interaction. Collins (2005) analyses how nurses' and doctors' roles are not just pre-defined formal roles, but rather distinctive interactional features constituted *in situ*. While the nurses' communicative pattern was characterised as mediated by the patient's contribution, the doctors' communication gave an overall direction to the practice as a whole (Collins, 2005). Particularly, this variation in communication patterns, related to the practitioners' distinctive roles, gives the patient different opportunities for involvement, which can lead to efficient consultation practices. Rees and Monrouxe (2003) establish how the use of pronouns and pronoun shifts affects the way in which participants conduct themselves in interaction. In the paper *Is it alright if I-um-we unbutton your pyjama top now?* (Rees and Monrouxe, 2003:171) they show how a pronoun shift functions to coordinate the relationship between the patient and the doctor, as the forthcoming activity is turned into a shared coordinative agenda: the joint activity of unbuttoning the patient's pyjamas top.

Putting forward personal motivations and agendas is a way of embodying moral and institutional order in interaction, identifiable in the sequential ordering of actions, or, more specifically, the choices participants make within the structure of turn-taking (Goffman, 1983). More specifically, this focus on the interaction order implies a focus on how participants jointly orient to and co-construct the medical practice by using a set of interactional resources as, for instance, repair and response variations. Pilnick and Zayts (2012) show how doctors in antenatal screening for fetal abnormalities are likely to control the interaction flow by withholding information or proposing testing rather than discussing possible implications when initial screening provides high risk results. This creative and controlling response strategy has also been unveiled in a study where patients expressed their aversion to medicines (Britten et al. 2004). In such cases, the doctors only exhorted the patients to take their medications, and their responses showed no interest in discussing any other view on the matter. Lehtinen (2013) emphasises how doctors' responses use hedging devices in their turns in order to fit the form and function of the patient's presentation of personal experience.

Several other studies have pointed to how interactional resources facilitate challenging aspects of medical conversations. For instance, Kettunen et al, (2002) highlight how patients are not just passive, but have options to construct power and affect the flow of interaction through asking more questions, interrupting and extending disclosures. Koenig (2011) adds how acceptable treatment recommendations are not just decided by the doctor, but negotiated with a patient that can show resistance and non-adherence in interaction. A more opaque example is provided by Aiarzaguena et al (2013) that show how doctors struggle with explanations concerning descriptions of highly complex biological processes:

> SEs [symptom explanations] also contained numerous markers of hesitation: turns that were re-started several times and abandoned before being finished, repetition of words, gaps during which the physician stopped talking within an unfinished turn, silences between turns, vowel elongations, and fillers (e.g. "uh" and "e:"). (Aiarzaguena et al, 2013:65)

This struggle is identified in the practitioners' imperfect and hesitant utterances with high degrees of self-interruptions, repetitions, silences, etc. (Aiarzaguena et al, 2013). While cases where linguistic categories are absent might evince hesitance in the flow of interaction, this is not tantamount to interactional struggling if it is analysed in relation to how bodily dynamics and gestures are played out. In some situations hesitations and silence are just cases of successful and smooth interaction. For instance gestures can be more precise and useful than verbal utterances that become superficial. When practitioner and patient co-act, much depends on trust and joint abilities to experiment and think together in dialogue. When coaction succeeds, it is often permeated with self-repair, hesitations and silences, and imperfect verbal utterances are often a sign of anticipation and probing rather than struggling. For instance, in chapter 6.2.2 I show a case where a doctor hesitates and makes self-repair as he comes up with a solution.

2.2.2.2 CA and video-data

With technological advances in video equipment came interest in analysing non-verbal aspects in interaction. As mentioned earlier, CA defines language in a broad sense: it is situated action that should be analysed with other multimodal resources (Mondana, 2008). In this review, a clear tendency emerges, as evident in the coding scheme (appendix A): the majority of the studies (65%) use video recordings as data. Surprisingly, only (32.6%) of those in possession of video data actually use the recordings explicitly in the analyses. It is hypothesised that a function of video recordings is to secure a better basis for verbal analysis – e.g. as validation of who says what to whom (Kettunen et al. 2001). Only four authors (seven articles in total) embed actual illustrations from the video data into their analysis. Most frequently, data are transcribed verbatim (Jefferson, 1983), and few non-verbal actions, such as head nods and sometimes shift in gaze, are annotated. For instance, Pillet-Shore (2006) shows how patients use non-verbal documentation processes as possibilities for delivering extensive information: "During the silence at line 9, the video shows the nurse (NR) gazing at the scale display and then turning his gaze toward PT's [the patient's] chart, starting to write. It is while NR is writing, apparently starting to record the displayed weight result in PT's chart, that PT delivers her utterance in line 10" (Pilley-Shore, 2006: 410). At best, non-verbal analyses supplement verbal analyses and add information about the sequential structure in interaction. This is seen in an example from Campion and Langdon (2004:92):

> We examined the doctor's gaze (Heath 1986, Greatbach et al. 1995), which during the explanation is fixed on the child, but briefly shifts to the computer on the doctor's desk, just before the father's interruption. As the gaze returns, the father speaks. This point also represents a potential closing, (lines 3–6) where the doctor's statement 'because this sort of thing does' is actually interrupted by the father's stuttering and accounted-for request to address a new topic.

When applying CA analytical procedures to non-verbal activities, conclusions are biased by the assumption that verbal and non-verbal utterances carry the same meaning potential, only articulated in different forms. In parallel to how Linell (2005) describes the extensive tendency to apply theories and methods suited for written language into the domain of interaction as a 'written language bias,' CA imports a "sequential order bias" into the domain of dynamic movement in interaction. For example, Greatbatch et al, (1995) illuminate how technology impacts practitioners' conduct and disclosures, and Poskiparta et al., (1998) underline how non-verbal communications such as attitude, gaze, etc. accompany verbal utterances. Nishizaka (2013) emphasises that changes in visual orientation are embodied movements of the head and eyes, and they are often the most crucial resources for sequential organisation of interaction.

Few studies use illustrations to show what happens and how a detailed consideration of embodied interaction is worthwhile. However, Nishizaka (2014) gives a thorough example of how a doctor uses his hand and fingers as a resource for showing what cannot be seen on a screen:

> This hand gesture, which is spatially and temporally positioned in the vicinity of the screen while the doctor mentions the fetal body parts (the legs), highlights the contour of the image of the fetal legs. Thus, the grey-tone images on the screen are structured such that the image of the fetal legs are differentiated, whereas the hand's shape with two fingers thrust downwards is also structured as isomorphic to the presumed fetal leg in this 'contextual configuration.' (Nishizaka, 2014:227)

Within the reviewed articles, most CA researchers do not report carefully on video analyses. However, there is a dawning realisation that gestures and body movement impact significantly on the organisation of interaction. For instance, Mondada (2012; 2014), Heath (2002), Goodwin (2000; 2002; 2007), Streeck (2009) and Linell (2007; 2009), Lindwall (2014), have all emphasised the importance of non-verbal actions in interaction. Interestingly, Goodwin's explanatory framework – for instance – deals with situated cognitive processes in a way that seems rather unconventional in orthodox CA practice. Moreover, when Linell (2009) stresses the dialogicality of sense-making and the function of communicative projects, he theoretically underlines how context, lived experience and silent others affect situated interaction.

Nevertheless, the impact of orthodox CA within the field of healthcare is massive and the inside opinion of CA's contribution is clear:

> The concrete findings CA generates can be used to help doctors (and patients) become more aware of and sensitive to their actions, which ultimately stand to improve health and healthcare. Frankel (1990), along with other pioneers in the field – including Christian Heath, Candace West, and Paul ten Have – took a firm stand that any recommendations for improving communication between doctors and patients must be grounded in the details of actual interaction. As West argues, "...it is only through systematic empirical study of the minutiae of doctor-patient interaction that we can learn what constitutes the alleged communication 'gap' between doctors and patients, and how it might be transformed." (Pilnick et al, 2009: 788)

At a practical level, every study contributes specific insight to a particular area within the field (antenatal screening practice, handovers, technology-supported practices) or to interactional phenomena of particular interest in medical setting (asymmetries, compliance, self-repair, evaluation, openings and closings etc.). The initial focus in the reviewed studies is often narrow and demarcated by an interest in a specific type of interactional sequence, for instance openings and closings (Lehtinen, 2013) or how a specific problem is managed or addressed interactionally. As such, the studies illustrate just as much the structural dimensions of conversation as the practical and theoretical implications of the interaction order. Generally, the studies have described the impact interaction has on outcome. It shows how members in interaction negotiate and jointly construct who they are, what they can do and how they can do it by using delicate interactional resources while at the same time maintaining the interaction order. In other studies the same conclusions apply. Murad et al, (2014) and Mikesell (2013) e.g. show how open-ended questions and positive polarity items elicit patient concern to a higher degree than closed questions and negative polarity (Mikesell, 2013). Heritage and Maynard (2006) summarise how numerous studies have suggested that interactional choices have a large impact on interaction itself and on its outcomes. For instance, they accentuate how responses to the question "What can I do for you today?" are four times as long as responses to questions such as "Sore throat and runny nose for two days, huh?" (Heritage and Maynard, 2006:365)

Evidently, CA is a huge player in the field of healthcare interaction. Following Salvage and Smith (2009), the relationship between medical practitioners and patients has never been unproblematic. Disputes over roles, status and responsibilities have characterised the medical domain. Due to CA studies, broadly accessible knowledge about how role hierarchies are maintained and how patients are concerned with much beyond bio-medical aspects in a medical encounter has been generated. On the basis of behavioural patterns identified in analysis, it is possible for practitioners to reflect explicitly on how they interact with their patients. At best, passionate advocates could be encouraged to develop a valuable strategy for how clinical practices should be organised at many levels. However, all findings are related to the sequential order in conversation, which biases the dynamical and non-sequential activities in interaction, and CA's approach is confined to dealing with micro-sociological aspects in conversation.

2.2.3 Critical evaluation of CA

The very bedrock of CA is its pointed focus on how sequences of actions are socially organised through turn-taking in interaction (Hutchby and Wooffitt, 2011). With Goffman, CA argued that structural organisation underlies all institutional interactions. This idea underlies all the studies reviewed above. The important undertaking of CA is, thus, to unveil these structures. As a result, CA has demonstrated how people accomplish tasks and construct roles and meaning through the complex organisation of speech, but I argue that it overlooks important aspect of what happens in interaction. In this section, the underlying principles of CA are critiqued in order to qualify the method's objectives. The critique is divided into three interrelated sections concerning: (*a*) the sociological agenda and member's perspective; (*b*) inductive 'unmotivated looking' and 'why that now' and (*c*) from one reductionism to another: CA and cognition.

2.2.3.1 The sociological agenda and member's perspective

CA has widely been criticised for being unable to respond to the *sociological agenda* (Hutchby and Wooffitt, 2011). In particular Critical Discourse Analysis has criticised CA for being unwilling to link micro particularities with macro levels of sociological variables (Fairclough, 1995a; 1995b). Detailed focus on particularities in interaction, as for instance turn constructions, complicates the relation between micro-analytical findings and general sociological claims related to gender, class, etc. (Nielsen and Nelson, 2005). Furthermore, another repeated critique is CA's lack of contextualisation of utterances that appear in wider social practices (Hutchby, 1999). CA finds it problematic to start with or to base itself on pre-established, sociologically contextual variables. CA disassociates itself from sociological claims about institutional characteristics as hierarchical power relations (Hutchby and Wooffitt, 2011). These critiques point lead directly to another CA stance concerning membership categorisation (Sacks, 1972). Hutchby (1999) defends CA by referring to how Schegloff (1998) eloquently defines CA's analytical imperative as a concern for how categories matter for members rather than analysts (Hutchby, 1999:86). CA's agenda, thus, does not immediately connect with the sociological agenda and:

> this quickly makes it problematic to talk in terms of sociological variables such as power, ideology, and so forth, because the typical sociologist's question is turned around: Rather than asking how social power affects the nature of the discourse, or whatever facet of social life is under scrutiny, we need to ask how, and indeed whether, the participants in a social scene show themselves to be oriented to power as a relevant phenomenon in the ongoing course of their interaction. (Hutchby, 1999:86)

Hutchby (1999) argues that when conventional macro-sociologists deal with a social theory encompassing invisible concepts of power, gender, class etc., CA is able to make such concepts visible by identifying the structures of interaction to which the members orient, and the consequences of this orientation in terms of showing how participants overtly categorise what they do (Hutchby, 1999:92).

Whereas CA makes a strong argument for denying that action is dictated by discourses arising outside local conversation, it is reluctant to deal with a more nuanced analytical perspective. Because CA confines its perspective to dealing with participants' first-person perspectives, the method ignores other important questions such as: "is this consultation good?" At best, the answer will rely on whether the treatment seems good from the local perspectives of the participants. If local, internal orientation contrasts with outside observations, CA ignores this inconsistency. According to Sacks, investigations should be concerned with what is observable, and this tends to be found in verbal utterances. For instance, Pilnick and Zayts (2012) define their locus of interest on the basis of observation: "We have focused our analysis particularly on consultations where these social and economic circumstances are interactionally visible, and the consequences that this presence has for how consultations unfold and how decisions are made and accepted or challenged" (Pilnick and Zayts, 2012:278). The analytic intra-logical perspective only allows for observations to be interpreted in a macro-sociological perspective when they can be explicitly tied to verbal utterances. When non-verbal utterances are dealt with in the reviewed studies, there is a tendency to treat them as interactional epiphenomena that only add information in the co-construction of meaning. Thus, the main focus is not on bodily dynamics *per se,* but rather on how verbal utterances are modulated by other multimodal resources. As a result, real-time inter-bodily dynamics and dynamic coaction are overlooked because actions are interpreted through the same socio-normative lens as verbal utterances. In contrast, my analyses demonstrate that relatively often participants themselves are unaware of the impact situated interactions have for their perceptions of their own roles.

2.2.3.2 Inductive approach and 'why that now'?

While CA claims that the inductive question "why that now" (Heritage and Clayman, 2010:14) serves as a guiding principle in its analysis, the review reveals the fact that analyses are far more often driven by pre-defined assumptions about how conversations work, as I will demonstrate below. Over time the inductive apparatus has consolidated a deductive, category-dense framework that guides the analytic gaze toward certain aspects in conversations. Inductively inferred generalisations gain status as a theory used to deduce explanations. The question 'why that now' was not addressed in the reviewed studies. Rather, based on sequentiality, interest falls on turns in interactions and how such turns relate to a pre-defined problem. In a recent article, Pilnick and Zayts (2012) state:

> A basic assumption of this perspective is that social interaction is structurally organized, and the focus of analysis is to uncover the socially organized features of talk in context. In analysing these data, we proceeded as follows. For each consultation, the opening sequence was analysed sequentially. More specifically, a display of a first medically relevant concern in a particular turn by the patient allowed us to locate the strategy, used by the doctor in immediately preceding talk that had 'occasioned' it. We also looked at the doctor's talk immediately after the patient's display of a concern in order to ascertain that our understanding

> of a particular sequence corresponded to participants' own understandings. (Pilnick and Zayts, 2012:243)

This statement directs analytical attention toward the mechanical structure of conversation. At the same time, it blindfolds the analyst, whose gaze is primed for spotting turns. If one is looking for turns, one finds turns. To give a few examples from the reviewed papers: "The analysis itself was carried out on a turn-by-turn basis. The principle behind our analysis was to examine how turns were taken with regard to other participants' speech and what sequential implications each turn had for the next" (Kettunen et al. 2001:403). Webb (2009) adds: "The key phenomena analysed are the structure, wording and timing of the doctor's questions; the structure and wording of patients' answers, as well as the topics the patients choose to address and the order in which they produce them; and the doctor's subsequent utterances after the patients' responses" (Webb, 2009:858); and: "When we examined nurses' and patients' speech word by word, we discovered four participation frames that produced taciturnity: in the hands of professionals, compliant, guilty, and polite" (Kettunen et al, 2001:399). CA's focus on turns has been related to production of speech. Its history of dealing with verbal turns *ad litteram* becomes its biggest obstacle. When interactions are transcribed verbatim, there is a risk that non-verbal actions are reduced to simple meaning transporters, and their dynamical characteristics are replaced by symbolic values. Thus, in the transcripts, only 'meaningful' actions are annotated (head nods, gaze orientation and gestures as pointing toward something in the same way as a verbal deictic marker). Remarkably, such actions are assigned the same rules as those valid for analysing verbal utterances. At worst, the non-verbal actions are completely ignored and it is hypothesised that this is due to the sociological explanatory framework that often works for verbal utterances but might be inadequate in the study of inter-bodily dynamics.

Although CA defines talk-in-interaction as its unit of analysis, its close-knit methodology primes the attention of the analyst to identify words in sequences of turn-taking. In such cases, dynamics extending beyond turn-taking will not be registered. In fact, CA methodology has, over time, accumulated a theory of conversation.

2.2.3.3 From one reductionism to another: CA and cognition

From Goffman, CA took the idea that structural organisation underlies all institutional interactions: "I assume that the proper study of interaction is not the individual and his psychology, but rather the syntactical relations among the acts of different persons mutually present to one another" (Goffman, 1967:2). As mentioned in the introduction to CA, and as Steffensen (2015) emphasises, CA became an important replacement of formal, generative and structural linguistic analysis of texts through its argument against language as an individual and internal system controlled by the individual's neural circuits within the brain. The CA position argued against the localisability of language within individuals, and rationalised that such a reductionist view was incommensurable with the idea that talk was a sociological phenomenon ordered by norms and rules across contexts. However,

according to Steffensen (2015), a closer look at CA's attempt to go beyond a reductionist view of language reveals that CA merely exchanges one reductionist view for another:

> Indeed, they tend to replace one reductionist model of language with another model that is no less reductionist. Thus, given that "The disciplinary motivation for such work is sociological" (Sacks et al., 1974:698), the conversation analytical model replaces the bio-reductionism of Chomskyan linguistics with a socio-reductionism that ignores the biological and ecological constitution of language. Evidently, it is fully legitimate to invest one's research interests in the micro-sociology of conversations, but it is illegitimate to assume that such a sociological perspective represents a better or fitter approximation to the complex reality that we call language (or conversation). (Steffensen, 2015:110ff)

CA's socio-logic replaced an intra-logic and changed the analytical point of departure, but it remained reductionist in its methodology. Reducing all interactional phenomena to social behaviour is a fallacy. Some activities in interaction play out too fast to be defined as social dialogue (Steffensen, 2013; Pedersen, 2012): thus, the explanatory frame should be qualified and developed further. For instance, gestures are not only relevant when they add local meaning to a conversation. In fact, meaning is often generated *post festum,* enabled by non-verbal dynamics in interactions.

Moving beyond this reductionism requires an ecological approach to interaction. In institutional settings, goals and tasks need to be accomplished. The achievement of a goal involves perception, action, reasoning, decision making, and as such, interaction is not purely social behaviour, but also bio-cognitive. Whether or not cognition, as an underlying basis, has a place in CA is a central question that needs to be addressed. Offhand, CA researchers do not participate in discussions about how cognition matters for managing interaction. Garfinkel's pun "there is nothing in the head except brains" (Garfinkel, 1963:190) refers to the belief that cognition is a mental state that is unobservable in natural interaction, and so not of interest for conversation analysts. Or, as Hutchby and Wooffitt, (2011: 220) emphasise: "Conversation analysts reject the determinism of cognition on methodological grounds, arguing that talk-in-interaction is an independent domain of activity, the properties of which are not dependent on psychological (or sociological) variables" (Hutchby and Wooffitt, 2011: 220). Or as Ataki (2012) argues: "There is in any case a profound difference between individuals' undemonstrated inner feelings, hopes and intentions […] and the visible 'participants' concerns' which are available for public consumption. […] CA's interests are in what is publicly transacted, not what is privately thought or felt" (Antaki, 2012:494, 497). Mistakenly, CA holds the view that cognition is clearly segregated from interaction activities due to its mental internalism. Only when internal cognition is represented externally through talk-in-interaction can it, according to CA, be treated as an analytical object, because the cognitive dimension of thinking transforms into a social phenomenon that members manage in interaction:

> cognitive and psychological phenomena are separate from social behaviour. They may be disclosed in social contexts, in that we can report our thoughts, verbalize our memories of events and articulate attitudes and beliefs; ultimately, though, they are not private phenomena.

> Finally, it seems uncontentious to assume that cognitive and psychological phenomena determine public social behaviour. (Hutchby and Wooffitt, 2011:217)

While CA's objections against interpretations of private thoughts, hidden mental processes and the importation of general discourses are appreciable, its understanding of the ontological status of cognition is flawed. Recent embodied and distributed theories about cognition break with conventional intra-cranial models of cognition, and in the cognitive sciences this tendency has dramatic consequences: the analytical attention moves away from brain-bound processes toward interactions between people in an environment (Hutchins, 1995a; 2014; Clark, 2008; Hollan et al., 2000). What people do together, and how they solve problems and find solutions, is not just a question of how they talk-in-interaction; it is just as much a question of distributed thinking. In that sense, cognitive processes or thinking are likewise observable activities that can be studied in detail. CA has adopted a model of cognition as an invisible phenomenon. However, when new models and perspectives, such as the ones provided by DC, show that cognition is not purely invisible, CA needs to address these insights and adapt its methods accordingly.

It seems rather paradoxical that the clear-cut distinction between linguistic and cognitive processes is less rigid than assumed by CA researchers. In fact, CA and DC work with the same basic material, but despite the fact that the two positions share a unit of analysis, they remain incommensurable on a theoretical and practical level. Finally, very few scholars attempt to bridge the gap between cognitive and linguistic endeavours. As an exception, a new group of scholars operate beyond a reductionist framework. In numerous studies, Goodwin (1994; 2000; 2003; 2007) Streeck (2009) and Heath (2002) amongst others, link situated cognition to how members orient to shared, material artefacts in interaction and how embodiments affect problem-solving activities. For instance, by opening up for dealing with multiple timescales in interaction, Goodwin (1994; 2002) shows how nature over time is being transformed into culture. In other words, micro-sociology is explained in relation to how predecessors have sown the seed of local action (Goodwin, 1994; 2002), and not just in relation to how local utterances emerge. Orthodox CA, as well as the reviewed studies, however, does not match this cognitive and non-local turn in interaction studies.

2.3 Cognition as distributed, embedded, ecological, extended, embodied and situated

In November 1980, Edwin Hutchins conducted a cognitive anthropological fieldwork on a U.S. navy ship that was on its way in the open North Pacific. As he stayed on the navigation bridge, he had access to the work procedures of the navigation team. After completing the first study of the navigation team, he realised that situated cognition was not individual but a social distributed phenomenon. Hutchins thus coined the term *distributed cognition,* and he articulated its main principles in his seminal 1995 book, *Cognition in the Wild.* He describes how his theory first and foremost is needed. It is radical, as he offers a new way to tie cognition with sociocultural practice. For instance, he

shows the distributed traits of cognition as it emerges in interactions and through coordination within a cognitive system (Hutchins, 1995a). In his study of how a navigation team serves as a cognitive, computational system, interest falls on the interaction within the system rather than on individuals and internal information processing. His findings are based on observations of naturally occurring events, which, according to Hutchins (Hutchins, 1995a:xii), was something his colleagues did not care about. The majority of his colleagues focused exclusively on experimental research detached from naturally occurring situations and it caused frustration - similar to the frustration experienced by Sacks within sociology:

> I became disillusioned with my field I lost interest in it. The choice of naturally situated cognition as a topic came from my sense that it is what cognitive anthropology really should have been about but largely had not been. Clifford Geertz (1983) called for an "outdoor psychology," but cognitive anthropology was unable or unwilling to be that. The respondents may have been exotic, but the methods of investigation were largely borrowed from the indoor techniques of psychology and linguistics. When cognitive and symbolic anthropology split off from social anthropology, in the mid 1950's, they left society and practice behind. (Hutchins, 1995a:xii)

DC is a contemporary product of intense developments in cognitive science. As part of the historical grounding of DC, the radical transformations that cognitive science has undergone within the last decades are briefly scrutinised before the perspective is elaborated further.

These transformations concern the nature of cognitive processes, which has a direct impact on methods and theories about cognition. Retrospectively, the transformations have been defined as first, second and third wave developments in cognitive science (Steffensen, 2012). In the classic view on cognition (the first wave) held by mainstream cognitive science during the 60s up until the mid 70s, computational models of internal manipulations of symbolic representations treat cognition as the link between perceptual input and behavioural output that occurs in a mental realm (cf. Boden, 2006). Behind this view resided the idea that cognition is reduced to symbol manipulation processes (information-processing) identical to how a computer processed information (cf. Newell et al., 1958). With advances in neuroimaging, brain scientists leapt into the domain of the human mind. Anderson et al. (2012) explain how such approaches, when relying on fMRI scans, propose that separate brain regions contain local information about cognitive faculties. For instance, faculties such as memory, reason and conceptualisation are traced to separate brain areas, and cognitive abilities are experimentally investigated in isolation, in relation to for instance attention (cf. Anderson et al. 2012). In this perspective, neural firings within the brain enable the individual to make mental representations of an outer world: this process was defined as cognitive. Such research explains important, useful features of the brain. But if the aim is to understand how human cognition works in real life, the brain-bound view misguides this scientific endeavour (Anderson, 2012). This modular view on cognition was soon replaced with connectionist models of cognition,

defined as second wave development (Steffensen, 2012, Jensen, 2014b). During the 70s, 80s and 90s, empirical findings pointed to how cognition was embodied in a way that challenged the inner-outer dichotomy radically. Although cognition was no longer treated as purely brain-bound, it remained body-bound, and the individual endured as the locus of interest for cognitive scientists. The second wave, though, cleared the way for phenomenological studies in the cognitive science, allowing for new discussions about perception based on, among others, Merleau-Ponty's thinking: "We encounter the world neither as data-crunching information processors, nor as ghostly apparitions floating over the surface of things like a fog. Perceptual perspective is *bodily* perspective" (Carman, 2008:11). The brain was understood in relation to a historical body, where perception of being in the world is intertwined with cognitive processes.

In this on-going cognitive development, the tendency to expand the location of cognition seems to continue, incorporating a growing range of parameters outside the brain and body. Thus, recently, a branch of cognitive science has again re-framed the status of brains, bodies and the world to achieve a more ecological and systemic view of cognition (Norman 1993; Salomon 1993; Hutchins, 1995a; 2014; Kirsh, 1997; 2009; 2013; Vallée-Tourangeau, 2013; Anderson et al., 2012). This ecological perspective on cognition has been described as a third wave of development within cognitive sciences. Several researchers have provided the field with various concepts that all share the criterion that cognition is not limited to a neurological substrate. Within the third wave development, Andy Clark's The Extended Mind Hypothesis (Clark, 2008) and Hutchins' Distributed Cognition (Hutchins, 1995a) have come to crystallise particularly.

Having moved from an internal, localisable and brain-bound view on cognition to an embodied, and then finally to a broader ecosystemic and distributed view on the matter, the object of analysis has been dramatically redefined (Hutchins, 1995a). Moreover, such a redefinition changes theory and methods, opening the field to interdisciplinary research. Within third wave cognition, distributed cognition has manifested itself as a valid perspective, which is elaborated in what follows.

Within the field of DC, Hutchins (1995a; 2014), Hollan et al. (2000) and Kirsh (1997; 2009; 2013) qualified their perspective and applied it in other areas – specifically in the domain of human-computer interaction. The DC perspective is special in the sense that it seeks to describe environments of interactions (Hollan et al, 2000). For instance it deals with interactions between participants and technologies, rather than taking one of them in isolation. As such, cognition is defined as distributed in and amongst people and material artefacts, and through time (Hollan et al., 2000). Hollan et al. (2000) argue that when one seeks to grasp cognitive processes from this perspective, three interdependent ways in which processes of cognition can be distributed are identified:

- Cognitive processes may be distributed across members of a social group
- Cognitive processes may involve coordination between internal and external (material or environmental structure)
- Cognitive processes may be distributed through time in such a way that the products of earlier events can transform the nature of later events. (Hollan et al., 2000:176)

Cognitive events can play out when individuals draw on material artefacts and exploit future events. As they do so they constitute a distributed cognitive system, which is "a system that produces cognitive outputs, just as an agricultural system yields agricultural products. The operation of a cognitive system is a cognitive process" (Giere 2004:771).

The DC perspective radically changed the understanding of where cognition flows, but it also forced researchers and designers to rethink design and design settings in general (Hollan et al, 2000). While DC, as well as other cognitive perspectives and theories, seek to unveil the organising principles within cognitive systems, DC innovates as it defines cognition beyond the individual:

> Cognitive science has a long history of studying the relationship between individuals' internal organizations and their behaviors in terms of information processing properties of the central nervous system […] Distributed cognition, by contrast, treats the activity system rather than the individual as the unit of cognitive analysis and considers the properties of this system that determine performance. (Hazlehurst et al, 2007:540)

In a similar vein, Goodwin expands the cognitive locus to "situated activity systems that make up the lifeworld of a work group. Within such systems, human cognition is embedded not only in biology and linguistic structure, but also history, culture, and the details of local, situated interaction" (Goodwin, 2000b:33). In all cases, interest falls on the cognitive system, rather than the individual. A cognitive flow permeates brains and bodies in an environment and cannot be localised in a fixed space-time. However, in particular cases, the boundaries of a cognitive system are not temporally or spatially pre-defined. For instance, DC emphasises that sometimes the individual is the right unit of analysis; sometimes it is too much, sometimes (and often) too little. The definition of the object of analysis is determined by a criterion of systemic function:

> A process is not cognitive simply because it happens in a brain, nor is a process noncognitive simply because it happens in the interaction among many brains. For example, we have found it productive to consider small sociotechnical systems such as the bridge of a ship [Hutchins, 1995a] or an airline cockpit [Hutchins 1995b; Hutchins and Klausen 1996; Hutchins and Palen 1997] as our unit of analysis. In distributed cognition, one expects to find a system that can dynamically configure itself to bring subsystems into coordination to accomplish various functions. A cognitive process is delimited by the functional relationships among the elements that participate in it, rather than by spatial colocation of elements. (Hollan et al, 2000:175)

Thus, turning to the place where cognition flows is a process guided by a principle of function and not by boundaries of the body or the skull. In lumping them all together, DC demonstrated its particular theoretical traits and strengths when analysing human computer interaction. It has a focus on developing design and technological solutions that make possible flexible adaptive behaviour.

While DC has moved away from internal information processing, it maintains the representationalist view of cognition. The process *per se* is not changed; only the location of cognition is negotiable due to the task to be accomplished:

> In particular, we treat the 'propagation of representational state' through activity systems as explanatory of cognitive behaviour and investigate the organizing features of this propagation as explanation of system and human performance. A representational state is a particular configuration of an information-bearing structure, such as a monitor display, a verbal utterance, or a printed label, that plays some functional role in a process within a system. (Hazlehurst et al, 2007:540)

Recently, Hutchins (2014) argues for a more ecological take on cognition. He introduces the notion of cultural ecosystems to demonstrate the non-local and supra-individual aspects of human cognition. He explicitly distinguishes DC from the extended mind hypothesis. He argues that DC takes a distributed cognitive system rather than the individual as the centre for cognition. The extended mind hypothesis, in contrast, deals with a mid-level spatial scale for cognition where the human being is always the centre of analysis. Moreover, the extended mind hypothesis distinguishes between extended cognitive processes and purely internal, mental cognitive processes. This is important as DC "is not a kind of cognition; it is a perspective on cognition […] Distributed cognition begins with the assumptions that all instances of cognition *can be seen* as emerging from distributed processes" (Hutchins, 2014:36). This claim makes DC a perspective on cognition rather than a hypothesis of how cognition flows to the most economical place, as is Clark's focus (Clark, 2008).

2.3.1 A DC literature review: search strategy, search process and selection criteria

This part of the review deals with a contemporary approach to cognition that is commensurable with the ecological framework in which this project is embedded. As mentioned above, distributed cognition (DC) (Hutchins, 1995a; Norman, 1991; Salomon, 1993) is a radical alternative to conventional intra-cranial and brain-bound theories about cognition. DC provides a framework that is useful to, though not confined to, the domain of healthcare, as it investigates cognition in relation to the environmental structures in which practitioners and patients are embedded. It is argued that no other approach to cognition seriously takes into consideration how teams generate output as they use tools and each other as cognitive resources in natural settings. DC is able to investigate how information and decisions are embodied and distributed in interactions that involve not just individual behaviour but also the tools and structures that are designed to facilitate and improve cognitive processes in healthcare. DC serves as an evident candidate in the investigation of how healthcare practitioners make decisions *in situ,* and its broad focus on how the environment affects cognition is the main motive for reviewing this perspective. Other externalist positions such as the extended mind hypothesis (Clark, 2008) and embedded and embodied cognition theories (Anderson, 2003) also emphasise cognition as being activity-based rather than about inner operations on symbols. Thus they too will be mentioned in the historical grounding of DC.

While DC in many respects – despite its relatively short history – is a well-established and widely acknowledged approach, it is not yet prevalent. As such, in the initial search

process, the number of hits was remarkably lower than in the previous section on CA. Using an almost identical search strategy, this part of the review similarly initiated the search process by searching the same 6 major databases within the fields of language, psychology, sociology and medicine. As before, the databases are 1) *Academic Search Premier,* 2) *Linguistics and Language Behavior Abstracts*, 3) *Web of Science*, 4) *PubMed Medline*, 5) *Scopus* and 6) *psycINFO*. The search string combination – "distributed cognition" AND "healthcare" in abstracts, titles and keywords – generated 75 unique hits in total. The abstracts were reviewed, and 28 articles met the inclusion criteria: a study uses DC on naturally occurring data (not mediated interactions, simulation or experimental data settings), and it investigates interactions between healthcare practitioners and conceivably artefacts. The data was extracted October 13th 2014, and all articles were published in English.

2.3.2 DC studies in healthcare settings: focus and findings

A striking similarity between the reviewed studies is the ubiquitous focus on material artefacts in healthcare interaction. Another related focus involves discussions about interventions in the material environment in which the practitioners operate. Thus the design of functional artefacts and displays that scaffold cognition efficiently is appreciated.

In my review, all articles were coded according to year of publication, overall methodology (e.g. ethnography), focus and empirical findings provided. The findings were summarised in 1 to 2 sentence descriptions that extracted the main contribution of a given article, see the table below for an example and appendix B for the complete coding scheme.

#	Author	Methodology	Focus of unit of analysis	Findings
1	Bang and Timpka (2007)	Ethnographic study	Human-artefact	In emergency situations the staff organises paper-based records spatially on a desk in order to create a base for shared communication within a team. The organisation enabled efficient communication overview, ranking of patients' medical status, etc. resulting in cognitive offload

Table 2.2 Review: Distributed Cognition AND healthcare

2.3.2.1 Artefacts and design

Clearly, the HCI heritage of DC influences the research interest in healthcare settings. Throughout the studies, special attention is given to how technological interfaces constrain both interpersonal relations and cognitive problem-solving.

> In our view, technologies are always embedded within activity systems and must be designed to serve the organization of those systems. The framework of distributed cognition allows us to simultaneously consider the roles of information-processing instantiated in diverse mechanisms involving diverse media within an activity system. Understanding technology in health care will require analyses that can describe the organization of the embedding activity system, and which can describe the cognitive effects created by specific technologies and practices within that organization. (Hazlehurst et al, 2007:551)

Bang and Timpka (2007:59) underline how a distributed cognition perspective emphasises cognition beyond the individual as it pays attention to how environmental structures, such as tools, direct cognition of the individual. For instance, the implementation of electronic medical records in the ward has proven to be on the one hand difficult, and, on the other, beneficial for medical outcomes and for communication between staff members and with the patient. Bossen and Jensen (2014) present a case where physicians achieve an overview by relying heavily on material artefacts, most importantly on the electronic medical record. In another study, Collins et al. (2010) emphasise that physicians prefer verbal communication over electronic documentation in information exchanges, as the practitioners felt the electronic documentation was 'a shift behind.' They perceived the documentation as ineffective for information retrieval, and it was not updated (Collins et al, 2010). Artefacts are ubiquitous in the ward, and, as pointed to in the majority of studies, knowledge about individual capabilities for dealing with them and their inherent potential for cognitive scaffolding must be analysed in great detail. Not only the electronic record is of analytical interest; the focus extends to other material artefacts in the medical domain.

In emergency situations, Bang and Timpka (2006) showed how a staff organises paper-based records spatially on a desk in order to create a visual base for shared communication within a team. The organisation enabled efficient communication overview and the ranking of patients' medical statuses, resulting in cognitive offload from the individuals. Evidently, tools and physical structures can both facilitate and constrain cognition. Besides detailed analysis of how the use of such artefacts affects decision making, the analytical outcome connects with discussions about how this insight has implications for future design of tools and other material artefacts in healthcare settings. For instance, developing electronic documentation tools that capture real-time information may lead to a more efficient practice (Collins et al. 2010). "The distributed view of cognition represents a shift in the study of cognition from being the sole property of the individual to being 'stretched' across groups, material artifacts, and cultures" (Horsky et al, 2003:7). By investigating the emergent properties of a system rather than individual behaviour, all studies pay attention to how information is distributed within a team and/or across artefacts. In that sense, focus is not purely on technological optimisation, but just as much on gaining expertise with how

tools work.

A profound argument in DC studies involves the advanced possibilities for designing interactive medical devices developed on the basis of observational studies of how they fit the specific context in which they should be used. Thus with DC comes cognitive ethnography:

> Cognitive ethnography is a methodology developed specifically to explore distributed cognition (Ball and Ormerod 2000; Hutchins 2003). It allows researchers to explore how cognitive activity is distributed across social and material artifacts (people and objects that aid, enhance or impede cognition) as well as over time. A cognitive ethnography involves integrating data across observations, interviews and exploration of social and material artifacts. By conceptualizing material and social artifacts not only as aids to individual cognition, but also as integral elements of distributed cognitive activity, i.e. activity grounded in the interaction between individuals and their environment (Hutchins 1995[a]), a cognitive ethnography provides a process analysis of cognition as it is enacted in the real world. (Mylopoulos and Farhat, 2014)

With cognitive ethnography, DC studies focus on how activity systems achieve goals and manage decisions. Artefacts are important cognitive aids that, over time, might function in different ways depending on the situation. The abilities of the individual in a local situation, thus, are pivotal to how action is tied to external structures. The studies provide a rich body of information about how artefacts either constrain or facilitate cognition and how distribution of information enables individual cognitive offload as information is shared in an environmental observable structure that is maintained with a minimum of cognitive effort.

2.3.3 Critical evaluation of DC

The reviewed DC studies highlight how medical practitioners manage cognitive overload by attending to material structures (including team members) that co-organise and represent information no single individual could handle by individual cognition. The studies emphasise how cognition is distributed in local interaction between a practitioner and his environment. However, explanations of how a distributed cognitive system manages cognitive processes are not fully elaborated. Below, it is argued that to come up with comprehensive explanations of the enabling conditions for local situated cognition, the trans-situational and non-representational aspects of cognition should be discussed explicitly. Such discussion will bring us closer to an understanding of how the use of external structures (verbal, physical etc.) is enabled by tying temporal distribution to sociocultural norms and experience. The main critique points relate to the following headings: (*a*) artefacts and local cognitive scaffolding and (*b*) representations, design and generalisations.

2.3.3.1 Artefacts and local cognitive scaffolding

Within the reviewed articles, there is a tendency to adapt DC as a framework that describes how healthcare professionals rely on technological artefacts in decision-making and on information sharing. As such, a prevalent argument for applying a DC framework is that the approach is ideal for investigating these types of cognitive processes. Yet, as Hutchins particularly underlines, DC is not a special type of cognition that is identified in certain circumstances; rather, cognition can always be seen as distributed (Hutchins, 2014). Thus, when Rajkomar and Blandford (2012a:588) emphasise: "One question this study sought to address was whether DC is particularly well suited as a theoretical framework to study healthcare socio-technical systems […] by looking at whether cognition was distributed in the ICU", they miscommunicate the underlying assumptions of DC. In a similar vein, DC is regularly reduced to a simplified framework for looking at how multiple aspects of a situation affect outcomes in a stressed environment. The overwhelming focus on artefacts is crucial to understanding why DC is widely acknowledged in healthcare: "Distributed Cognition has been proposed as being a framework of choice for studying healthcare work. It is particularly well suited for studying interruption resumption since it explicitly considers the design and use of artifacts, which play a crucial role in supporting interruption resumption" (Rajkomar and Blandford, 2012b:108).

Thus, in the studies, focus falls on how external structures materialise in artefacts and how such artefacts scaffold cognition within a spatially distributed cognitive system. However, the perspective is more than a context sensitive model of cognition that takes the role of external artefacts into consideration. While Hollan et al, (2000) identify three ways in which a cognitive system can be distributed (in time, in and between people and in environmental structures), the reviewed studies almost exclusively emphasise how information processes are facilitated by technological solutions in various ways. For instance, such solutions reduce cognitive overload (Bang and Timpka, 2006), enhance medical overview (e.g. Bossen and Jensen, 2014) and imply a coordinating role for action (Rajkomar and Blandford, 2011). Although this is useful knowledge, a narrow focus on functional properties of artefacts reduces the explanations of decision-making to how physical materiality impacts action in relation to a specific task. It appears as if activities that do not contribute to a smooth and immediate accomplishment of an explicit goal are evaluated as either dysfunctional or unimportant. Local detours related to interpersonal issues (for instance, concerns about the well-being of team members, calming down patients and chatting with relatives) and other situational features are not addressed explicitly in the DC studies. However, rather than being *noise* in problem-solving, such detours often serve as anticipatory activities that, by a circuitous route, enable an overall more effective accomplishment of goals. This will be demonstrated in the analyses.

The immense focus on problem-solving in the DC studies entails a single-minded reading of activities in the cases investigated. By defining a problem space, a task and a pre-defined goal, much is left out in the process of achieving that goal: "Problem solving research typically focuses on how subjects find their way through an abstract problem space. However, placed in a concrete and imaginable setting, one can scrutinise what

happens“ (Cowley 2014b:243). Cognitive science applies models of cognition and test hypotheses, providing clear, demarcated and comparative results but leaving out the relevance of dynamics in human interactivity that cannot be classified as logical task performance. In the search for explanations of information processing and functional properties in task accomplishment, the concept of representational states in particular is explored. According to this perspective, it becomes relevant to investigate how effective representations are embedded in the ubiquitous artefacts that are used in healthcare decision-making (Kaufman et al., 2009).

2.3.3.2 Representations and artefacts

With the ethnographic approach, analyses based on interviews and video-observations, generally highlight how information flows with the aid of artefacts. Informed by rich data material, the conclusions are based on a rather outworn understanding of communication and language processes. For instance, Kaufman et al., (2009) indulge in a Turing-like model of information transmission in their otherwise convincing investigation of how technological issues affect workflow in telemedicine: “The information was transmitted through eight communication modalities […] Three of them are synchronous and the remaining five are asynchronous. […] The medium of communication provides different resources for establishing common ground or mutual understanding" (Kaufman et al., 2009:584). Ironically, DC represents third wave developments in cognitive science, where the computational metaphor of cognition is exchanged with a more ecological and contextual understanding of the matter. Nonetheless, several DC studies blend a third wave systemic approach with old school conceptualisations that reduce cognitive processes to computational calculations of representations: “Sensemaking as a process of reciprocal, ongoing interaction between the search for information, meaning ascription and action fits nicely with our empirical data. Also, it makes good sense to consider the distributed socio-technical system the primary analytical unit, as suggested by distributed cognition, and the achievement of overview a computational process across actors and artefacts” (Bossen and Jensen, 2014:266). In their study, the classic metaphor of the cognitive domain – cognition as computation – is adopted and guides the analysis. Hansen and Lyytinen (2009) emphasise how Van Gelder (1995) has criticised this view on cognition in a critique of DC: “Thus, intelligent behavior (i.e., cognition) is understood as an information processing mechanism that results in appropriate action toward the achievement of specific goals: “the mind is a special kind of computer, and cognitive processes are the rule-governed manipulations of internal symbolic representations” (Van Gelder, 1995: 345). While the focus is on artefact-based tasks, the processes of information, memory and representation in relation to how a goal is achieved are sought at the expense of an understanding of the multi-scalarity of human interaction.

Finally, while the cognitive sciences have been preoccupied with statistical analysis of how output is generated, the ethnographic approach in DC-studies apparently contrasts with conventional, experimental approaches. With DC the context is crucial to how results

are produced. DC's context sensitivity favours particulars and deals with the reciprocal and dynamical relations within the distributed cognitive system. System output is a result of how individual capabilities are used in interaction with what the environment offers. As interaction continuously affects how the system operates, standardisation and generalisation of the enabling conditions for decision-making are challenging:

> Taking context seriously means finding oneself in the thick of the complexities of particular situations at particular times with particular individuals. Finding commonalities across situations is difficult because studies may go off in so many different directions, making it problematic to provide the comparative understanding across domains that Brooks (1991) advocates. How can we confront the blooming, buzzing confusion that is "context" and still produce generalizable research results? (Nardi, 1996:70)

However, as much depends on situations, particulars are often highlighted in DC-studies followed by a request to look deeper into similar cases. Critical qualitative research suffers from the authority of the ordinary conception of conventional rules for generalisations. However, rather than being just 'a cup of coffee theory of understanding', as the philosopher Karl-Otto Apel (1973) describes qualitative studies, reliable qualitative research insists that general features are connected with particular situations:

> there are not just particulars in concrete situations […] For example, anxiety holds distinctive general qualities and significances which have to do with losing one's grip over one's situation (Holzkamp, 1983). Knowing such general features is helpful in guiding the understanding of concrete anxieties. But concrete anxieties also hold particular personal and contextual qualities and significances. (Dreier, 2007:190)

To sum up, DC has been preoccupied with functional manipulations of external structures. The immense focus on how artefacts are used as cognitive resources is tied to only one of Hollan et al.'s (2000) three dimensions of distribution. A few studies emphasise what the perspective originally sought to describe: how teams manage complex tasks with clear and distinctive operational criteria for accomplishment. For instance, Fioartou et al. (2010) investigate how distributed situation awareness helps avoid fixation errors. Still, at an empirical level, cognitive distribution in time is not emphasised in any notable way, and the way in which culture, experience and social phenomena influence situated cognition is left for general reflection and theoretical discussions.

2.4 Conclusion: incommensurability and the next step

Where CA observes local behaviour and the development of interaction through turn-taking systems, DC points to how activity systems achieve goals through the distribution of information. At a practical level, the two positions provide different outcomes. CA unveils communicative patterns that relate to how individuals manage and construct roles, identities and power in interaction. DC, on the other hand, emphasises how technologies and other material artefacts are used for cognitive purposes, e.g. decision-making and

problem-solving.

From a data perspective, CA and DC work with the same basic material. However, when investigating naturalistic ethnographic data, they come up with rather incommensurable explanations and descriptions of how coordination is managed. DC favours embodied information processing within a distributed cognitive system with functional properties, while CA underlines the sequential organisation of social orderliness in a local negotiable situation. In both cases, the enabling conditions for human coaction are reduced to a single domain of either social orderliness or representational states.

In the investigation of the social practice of human interaction and errors in emergency medicine, the two positions appear incommensurable at practical, theoretical and methodological levels. Thus, the major positions within this field are inadequate in the exploration of the phenomenon in its ecological entirety, which entails a scientific gap between problems experienced in practice and findings provided by research. This scientific gap is addressed with the presentation of an analytical framework (the forthcoming chapter 3) that allows for investigations of the social practice of human interaction in a way that considers the challenges raised by the two initial chapters. The analytical framework synthesises the best from the cognitive sciences and the humanities to achieve commensurability at a practical, theoretical and methodological level.

3. Establishing an analytical framework of human interactivity: empirical enquiry and theoretical perspectives

3.1. Introduction

The two introductory chapters underline why the social practice of human interaction in emergency medicine needs further exploration to identify how error cycles emerge and are managed, and that the major positions within this field inadequately explore the phenomenon in its ecological entirety. A scientific gap between problems experienced in practice and findings provided by research remains. This gap will now be addressed with a presentation of an analytical framework that allows for investigations of human interactivity in a way that meets the challenges raised by the two initial chapters.

As the project is based in an ecological paradigm, it rejects approaches that reduce the complexity of human life to a single perspective. While the positions reviewed (see chapter 2) reduce human interaction and cognition to the domain of the social order and to external representations of structures respectively, both explanations appear reductionist. First, I criticised the explanatory framework of CA: interaction cannot be reduced to a social phenomenon. CA does not fit an ecological understanding of human interaction because it demarcates its focus to social normativity and reduces all observed phenomena to the social order. From an ecological perspective, interaction is bio-cognitive, and thus enabled

by biomechanics just as much as by the social order constructed through local coordination. Second, I criticised the computational model underlying conventional DC, which favours representations and procedures at the expense of inter-bodily dynamics and non-local sense making. Furthermore, DC lacks concrete guidelines to identify the effect of temporal distribution in local interaction. None of these approaches to human interaction and cognition in healthcare succeed in linking situational and trans-situational phenomena convincingly. What DC has in principle, it lacks in applicative value, while CA's impressive methodological apparatus only unveils part of human interaction: the enchronic timescale, which according to Enfield (2014) covers the context of social interaction.

When human beings are viewed as bio-cognitive social beings, interaction cannot be explained through the lens of social normativity only, or through the lens of biology only. Both approaches are reductionist (Steffensen, 2015). Finally, chapter 2 identified an explanatory gap due to the incommensurability of the two reviewed positions, which leads to inconsistent and limited methodologies when investigating the full array of human interaction and cognition (Streeck et al., 2011; Streeck, 2010; Goodwin, 2000a; 2000b: 2003; 2007; 2014). The lack of a consistent and comprehensive methodology provides the present chapter's objective: to present an analytical framework of human interaction and cognition that integrates the best from cognitive sciences and the humanities. Rather than pursuing an accumulative approach (adding cognitive and linguistic analyses), the approach outlined here pays attention to how people manage projects and achieve goals by integrating cognition with language (Love, 2004). For instance, Cowley (2007; 2009 2011), Thibault (2011); Steffensen (2013) amongst others, treat joint activity as flexible adaptive behaviour, involving cognition *with* language. Specifically, they emphasise how cognitive dynamics and whole-bodied utterances are embodied in interaction.

In this chapter, I present an interdisciplinary framework on the basis of complementary movements between deductive theoretical perspectives, inductive data-driven approaches and phenomenological reports. Thus, by drawing on synergies from various domains, it emphasises how cognition in interaction is nourished by both local dynamics and relatively stable non-local patterns (Love, 2004; Thibault, 2011; Cowley, 2010; 2011). The framework's strength is that, as it investigates the full ecological array of human interaction, it allows for acceptable explanations of how organisational culture and norms serve as an attractor for local behaviour. To explain such an attractor, one cannot investigate what happens as purely situated emergent phenomena. Rather, I aim for a dual orientation to cultural and biological dynamics that co-regulate how people manage to do things together. Such double and ecological orientation is incorporated in the analytical framework to entail research commensurability without losing analytical precision and consistency. Finally, the framework aims for theoretical insights supported by empirical investigations in order to develop new methods for exploring human interaction and cognition. It is hypothesised that the interdisciplinary framework of human interactivity provides a higher degree of explanatory power regarding how human beings make sense and achieve results than existing models in the humanities and cognitive sciences.

The chapter is structured into six sub-sections. Initially, it discusses paradigmatic

concerns in relation to an ecological paradigm that builds on a principle of non-locality. Within this paradigm, interactivity is introduced as a basic substrate of human coordination that connects non-local and local aspects of human interaction. To examine the temporal complexity of this substrate, an ecological timescale concept is presented and related to the local and non-local dimensions of human interaction. The temporal complexity of interactivity is discussed in relation to the methodological challenges such a view elicits. Taking the methodological challenges into consideration, the interactivity-based framework builds on three relevant perspectives: interaction, cognition and ecological psychology. Each perspective offers useful approaches in the investigation of how people achieve goals and manage projects. The approaches variously have their strengths over different temporal ranges of human interaction. Finally, the interactivity-based framework is discussed in relation to its analytical possibilities in real-life investigations.

3.2 Paradigmatic concerns

3.2.1 The ecological paradigm and the principle of non-locality

Kuhn defines a *paradigm* as: "universally recognised scientific achievements that for a time provide model problems and solutions to a community of practitioners" (Kuhn, 1962/70:48). In that respect, it can broadly be defined as a framework that generates a specific thought and action pattern within a given scientific discipline. Within the humanities, a paradigm favours certain perspectives on human mind and life and it gives rise to particular theories about the matter. The distinction between *theory* and *perspective* is important: "Scientific theories are supposed to be based on known facts, and the facts are determined by observation" (Ladyman, 2010:109). According to this understanding, a theory can be tested and falsified. A perspective, on the other hand, is a point of view, from which to categorise, generate meaning and provide descriptions of the world (Hutchins, 2014). A perspective is tied to foundational beliefs that cannot be tested on the same premises as a theory. For instance, the distributed language approach (DLA) (Cowley, 2011) presents the distributed language perspective that treats language as multi-scale co-ordination (Cowley, 2011:1) and it can hardly be falsified. Likewise, distributed cognition is a perspective (Hutchins, 2014) and Hutchins explicitly contrasts it to the extended mind hypothesis. Both DC and DL perspectives fall under the ecological paradigm.

At a basic level, an ecological paradigm embraces a phenomenon in its wholeness - that means as part of a larger system than that which appears in real-time. Moreover, any individual is in direct relation with its environment, which means that the relation is not mediated by representations. Action is a result of a relational, structural coupling between an individual and its environment (Maturana and Varela, 1987). An explanation of behaviour thus requires an investigation of a system, rather than of individual components within the system. A system, from an ecological perspective, is open and complex due to its emergent properties. According to Steffensen and Cowley (2010) a basic ontological principle within an ecological paradigm is the principle of non-locality, which: "denies that states or processes can 'occupy' a determinate space-time zone" (Steffensen and Cowley,

2010:337): everything is in a continuous state-of-becoming (Major, 2010). The idea of non-locality appears in many recent approaches within the humanities and the cognitive sciences. For instance, it relates to post-Cartesian perspectives on the mind as embedded, extended (Clark, 2008), and distributed (Hutchins, 1995a; Hollan et al., 2000). As mentioned in chapter 2, the reorganisation of the cognitive locus eradicates the distinction between inner, cognitive domains and outer, environmental realms. Likewise, the non-local perspective blurs the distinction between biology and sociology, as it allows for explanations of how biological beings become social agents. Steffensen, (2015) argues that human biology is not just individual. Social interaction, or dialogue, is rendered possible due to the dialogical capacities of our bodies: "Nature is a vibrant, living ensemble of sentient beings that co-exist and coordinate through adaptive, flexible behaviour, enabled by their cognitive capacities–and in the instance of human beings, their capacity for sense-making (Steffensen, 2015:114). A naturalised perspective on human interaction does not necessarily imply a reductionist methodology. Rather than tracing human interaction to bio-chemical processes within individuals, an ecological paradigm invites investigations of how bio-cognitive individuals become social over time as they repeatedly coordinate and engage in dialogue (Linell, 2009; Steffensen, 2013).

Understanding situated activity as an emergent possibility enabled by inter-bodily dynamics and non-local conditions opens up new ways of describing human interaction. Moreover, it implies a naturalised perspective on human interaction that takes its starting point in the biological capabilities for human action, coordination and sense-making (Cowley, 2011). The focus of analysis is thus redefined as a process of sense-saturated coordination rather than a physical system or local object.

3.2.2 Interactivity as object: perspectives on coordination

Steffensen (2013) argues that at the core of human action, one finds sense-saturated coordination, defined as interactivity:

> Defining interactivity as sense-saturated coordination that contributes to human action characterises three aspects of the relevant phenomena. First, coordination refers to a reciprocal flow of minuscule, pico-scale interbodily movements that link and lock human beings in self-organised systems. […] Second, this coordination is sense-saturated, that is, it is pervaded by our species-specific capability for sense-making (Linell, 2009). We engage in sense-making as our bodies integrate present circumstances with autobiographic memories and sociocultural histories: through sense-making the not-here and the not-now saturate our here-and-now coordination. Third, sense-saturated coordination constrains what we do and how we do it. (Steffensen, 2013:197)

While interactivity has a primordial quality, it is in vain to *explain* interactivity in all its complexity by single perspectives coming from distinct fields. The framework presented in this chapter, seeks to provide an ecological account for human interactivity by allowing multiple perspectives to capture different temporal dynamics in interaction. These

perspectives are interdependent descriptions that inform each other in the analytical process, such that the non-local is understood in relation to the local and vice versa. Steffensen adds:

> Underlying each perspective, one finds interactivity: it is an ontological substrate that each discipline has turned into an 'object.' While all three perspectives [cognitivist, microsociological and biological] may yield descriptively adequate models within an epistemological domain […] they cannot, in themselves, provide an explanatory model of interactivity, i.e. of what really happens in the flow of human existence. (Steffensen, 2013:196)

The interactivity-based framework does not operate with a clear distinction between language and cognition. Rather, it prioritises what individuals actually *do* in real-life situations as they draw on experience and non-local constraints (Thibault, 2011; Love, 2004). Following Cowley (2011), the framework proposes that people engage in whole-bodied activities that enable sense-making processes. Thus, attention must be paid to how individuals orchestrate speech, thinking and gesture by turning to bodily dynamics *and* symbols (Cowley, 2011; Rączaszek-Leonardi, 2011). By viewing language as ecological, distributed (Cowley, 2011 Love, 2004; Thibault, 2011; Steffensen, 2011; 2013), and grounded in coordinating bodies, the synchronic system view on language must be rejected as being too shallow (Cowley, 2011). Rather, language must be investigated as a non-local whole-bodied activity that enables action, perception and cognition (Steffensen, 2011). Language is not reducible to biology, but it cannot be understood without its biological grounding. And human language is unique since it has "catapulted and stabilized human cognition in ways that are unequalled in the ecology of any other species. The human ecology is radically *extended"* (Steffensen, 2011:204).

The ontological claim of interactivity guides one toward an understanding of the enabling conditions for human action. Building on Steffensen's (2013) argument, I suggest that the concept of interactivity enables explanations of the whole array of human coaction, spanning from its enabling conditions to how it is managed and how it causes cognitive results. Investigation of such extents allows for a multi-scalar view on local interaction and cognition conducive to the notion of timescales and temporal ranges (Uryu et al, 2013; Steffensen and Pedersen, 2014; Pedersen and Steffensen, 2014), which will be elaborated in detail below.

3.3 Timescales and interactivity

An ecological paradigm emphasises the systemic features of human coaction. It changes the focus from social interaction to human interactivity as a mode of social and ecological cognition that flows as inter-bodily dynamics on multiple timescales (Kirsh, 1997). By turning to the domain of interactivity, traditional approaches to human interaction are challenged. If we opt for understanding human interactivity, we cannot escape the notion of timescales:

> There simply is no single time scale of an ecological phenomenon. […] Acknowledging that such ecological phenomenon as brain activity […] cognitive performance, human conversations, and social practices all and each unfold on multiple time scales, we need a model that does not reduce time scales to a tiered hierarchy of duration. (Steffensen and Pedersen, 2014:87)

Steffensen and Pedersen (2014) argue that time is a phenomenon that relies on emergent dynamics of human systems. *Lived time* of ecological living systems is governed by complex and multiple causal frames (Enfield 2014) that relate to biology, cultural narratives, purposive behaviour and situated awareness (Steffensen and Pedersen, 2014). Because ecological systems are governed by multiple causal frames, external criteria (specific research questions within a specific scientific domain such as geological changes or human interaction) help define, which *temporal ranges* should be investigated further. A temporal range is defined as a "limited range of time scales within which self-similarity appears" (Steffensen and Pedersen, 2014:87). Thus, in the study of human interaction and cognition, it makes sense to focus on the temporal range of a dialogical system encompassing conversational timescales, inter-bodily timescales and event timescales. However, as individuals recruit sociocultural resources, enabling conditions for local sense-making are complex and multi-scalar.

Conventional approaches have prioritised and simplified what appears to happen in real-time and reduced it to few causal frames, often fixated on one local timescale (cf. chapter 2). An awful lot more can happen in a situation than a conversational timescale shows, since interactivity is carried out by sense-saturated living beings. Sense-saturated human beings are time-rangers (Pedersen and Steffensen, 2014:95) who, due to their sense-saturated biosocial bodies, are able to recalibrate dialogical systems and achieve relative stability in the organism-environment system of which they are part. With the method of cognitive event analysis, focus is on how disturbances, fixations and other constraint on action affect functional coordination (this will be elaborated in 3.5.1). It is hypothesised that such moments, where a system experiences boundary constraints, reveal a lot about how sociocultural timescales and embodied, situated activity co-direct action in the context of what happens.

Investigations of multiple timescales in interaction require methods for collecting data that are yet to be qualified in a coherent analytical model. However, isolated, detailed investigations will not do the trick. While some processes related to slower timescales are enacted and made explicit (in verbal utterances, body movement, orientations etc.), others remain implicit even though they may serve as constraints in the situation (for instance private – though still distributed – thoughts and autobiographical memory). Thus, consequences of the implicit can be observed but an understanding of them, and their enabling and causal conditions, requires interpretation. Importantly, non-local timescales are not like discourses that provide us with a heuristic in the analysis of the local. Rather, focus is on timescales concerning cultural dynamics and symbols, sociological normativity and rules, embodied experience and habits. These phenomena are patterns that are re-enacted in local interactions in creative ways. It is argued that explanations of enabling

conditions for action are only provided through investigations of the non-local in the local, i.e. through a double orientation to how situated action re-enacts (and shapes) non-local patterns.

At an analytical-methodological level this mesh-view entails an inductive-deductive, or abductive, oscillation between locally generated observations and theoretical perspectives on the local. To identify the slow emergent properties in rapid coaction forces the observer to point to the stabilising functions within an adaptive flexible system that finds its own way in the world.

3.3.1 Perspectives on interactivity and its methodological challenges

In institutional settings it becomes vital to understand how outcomes are enabled by several causal frames that relate to biology, sense-making, purposive behaviour, sociality, and awareness (Steffensen and Pedersen, 2014). By emphasising interactivity as the underlying explanatory framework of a cognitive system, the unit of analysis becomes increasingly multifaceted. A methodological concern is *how* interactivity connects the rapid processes of real-time embodied coaction with situation-transcending processes of social knowledge, norms and meaning – in a way that yields results (Pedersen and Steffensen, 2014). It becomes relevant to zoom in on how individuals co-act, coordinate and use artefacts in their environment even as they draw on sociocultural patterns and personal experience.

From an interactivity point of view, the observational starting point is a cognitive system (i.e. a dialogical system (Steffensen, 2012) with a cognitive agenda). According to Steffensen (2012), individuals constitute a dialogical system when they interact in real-time. A dialogical system emerges locally as individuals coordinate their situated behaviour (Steffensen, 2012). However, they also draw on non-local social systems defined as trans-situationally coordinated behaviour of individuals. To explain how the system manages cognitive results, attention must be paid to how social systems affect the dialogical system and how the dialogical system feeds back on the social system. For instance, accounts of phenomenological experiences of how interaction is managed must be an issue in analysis. One hypothesis is that the observable effect of local coordination does not necessarily correspond to participants' phenomenological experiences of behavioural coordination (see chapter 10.2). Thus, observations might be able to identify discrepancies between situated, bodily sense-making played out on a very rapid timescale and explicit accounts of what happens in a situation (often constrained by social norms and rules); for example, when pitch and gaze orientation indicate a concern that is not expressed explicitly in verbal utterances and goal-directed actions. Practitioners' sense-making *in situ* is often radically different from their reflections of their situated sense-making. Understanding such discrepancies between observations and phenomenological reports is important in recognising how actions are shaped beyond individual intentionality. In the long run, when perceptions diverge from performance and happenings, the idea of what happens can have consequences for how practitioners

anticipate problems and solutions in future situations. For instance, in some cases, I perceived how practitioners experience constraints that are not present and they behave as if they were stressed even though sufficient resources (time, qualifications, practitioners etc.) are present. Such experiences affect what they do and how they engage in future diagnostic processes. The interactivity framework uses ethnographic methods, theories and perspectives to investigate the full spatio-temporal array of human interactivity.

As this discussion illustrates, ecological analyses encompass a multi-temporal focus. Taking interactivity to be the basic element for observation, three relevant perspectives in the explanation of human action are introduced: interaction, cognition and ecological psychology (see figure 3.1).

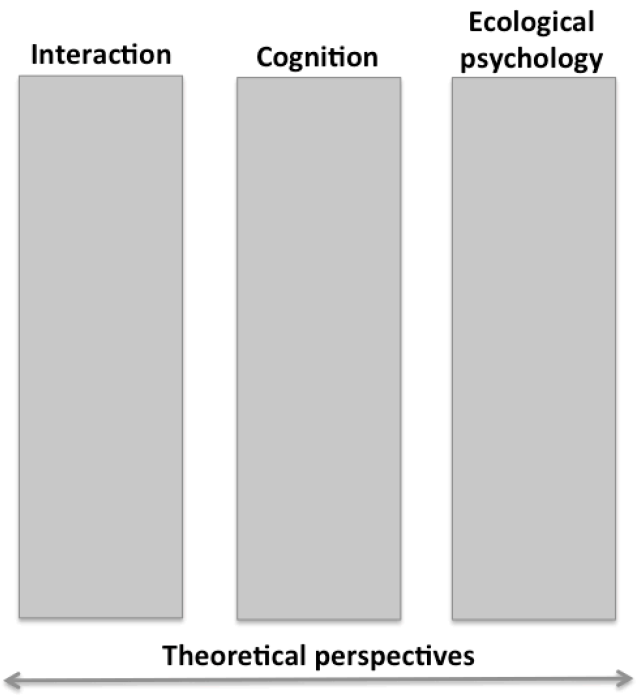


Figure 3.1: Three perspectives on interactivity

If interactivity is a substrate of sense-saturated coordination that links past and present, different perspectives contribute to a deeper understanding of interactivity as particularly human, non-local and sense-saturated. As mentioned above, the human ecology is extended due to the human biological capabilities for trans-situational sense-making (Steffensen, 2013). By showing how language and cognition shape sense-saturated coordination over time, culture, norms and intentions can be dynamically linked with real-time perception and action.

First, with the perspective of ecological psychology, emphasis falls on how an organism-environment-system (Järviletho, 1998; 2009) coordinates its action by perceiving a world of value (Gibson, 1979/86; Hodges and Baron, 1992; Noë, 2004). Second, a cognitive perspective focuses on how tasks are managed and results are achieved by drawing on skills and knowledge in a material world (Hollan et al., 2000). Third, by taking interaction

into consideration, an ecological account prioritises the collective and contextual dimensions of language: "Language can be traced to how living bodies co-ordinate with the world. On this perspective, far from being a synchronic 'system,' language is a mode of organization that functions by linking people with each other, external resources and cultural traditions" (Cowley, 2011:2). Further, Linell (2009) adds that a dialogical approach: "deals with the actual performative actions in the world, rather than just languages as abstract or mental objects as 'used' (Linell, 2009:274).

The three perspectives combine useful analytical and theoretical approaches in the investigation of how people achieve goals and manage projects by drawing on multiple timescales. In the following, the approaches, with their respective strengths on different temporal ranges of human interactivity, will be presented and placed within the interactivity framework (see fig 3.2).

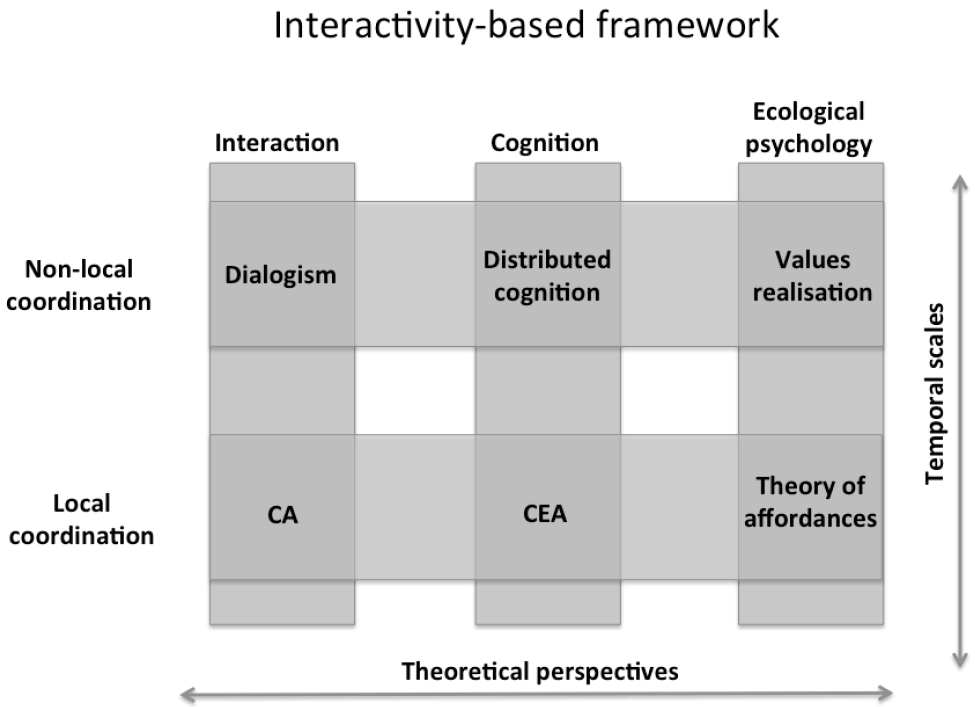


Figure 3.2: The interactivity-based framework

Importantly, the framework underlines that the non-local is always in the local. The theoretical perspectives are tied to an analytical focus defined by a particular approach interested in particular temporal dynamics of interactivity.

3.4 Ecological psychology

3.4.1 Affordances and the local

The first perspective in the framework is ecological psychology. Within this perspective Gibson's theory of affordances (Gibson, 1979/86) is paired with Hodges and Baron's theory of values realising (Hodges and Baron, 1992) to stress the local and non-local

conditions of interactivity.

An understanding of how individuals solve problems, recognise challenges, navigate in the environment and manipulate artefacts requires an examination of perception. Coming from ecological psychology, Gibson (1979/86) emphasises perception as an emergent phenomenon that relates to both local environmental circumstances and biological capabilities for dealing with an environment in species-specific ways (Gibson, 1979/86). To Gibson, a theory of perception must be concerned with a body in motion: he replaced the behaviourist stimulus-response model with one of optical flow to emphasise how objects in the visual field change their appearances relative to an observer (Gibson, 1979/86). Interactivity is a keyword, as perception is a result of how an individual engages with his environment, and as such, perceiving goes on as a never-ending process that endures throughout life (Gibson 1979/86).

An environment constantly offers possibilities for action that emerge as *affordances* when paired with a particular animal's abilities for interacting with the environment and for using the possibilities to realise values. Gibson coined the term affordances: "The *affordances* of the environment are what it *offers* the animal, what it *provides* or *furnishes*, either for good or ill" (Gibson, 1979/1986:127). Gibson's ecological approach to visual perception supports the dialogicality of perception in interaction. The environment affords the organism with direct perception of things, i.e. as a non-representational activity, on the basis of the value it has for the organism. Thus, moving beyond a representationalist approach to visual perception, Gibson's theory of affordances emphasises the dynamical and contextual elements involved in visual perceptual systems. Gibson prioritises the local timescale in the investigation of an animal's encounter in a physical terrain. As mentioned above, a qualitative difference between the human species and other species is the human capability for trans-situational sense-making. By emphasising the historicity of human perception, Gibson's theory of perception can be extended in time (so sociocultural patterns frame direct perception) and not just in space (moving away from inner representations to organism-environment relations). The focus on slower timescales in local coordination is crucial for understanding how persons differentiate situations that are akin to each other. The historicity of perception provides an individual with a value-directed attention to acting and perceiving in particular situations. In the local, anticipatory actions can be interpreted as a result of a rich visual system that transgresses the situated. Investigating emergent affordances in interaction requires a primary focus on the local dynamics of movement and the physical materiality of the environment but it should also be understood in relation to experience and moral obligations to perform in a certain way, which will be addressed further below.

3.4.2 Values realisation and the non-local

Behind Gibson's contextual, functional theory of direct perception as the manipulation of stimuli lies an ecology of values that goes beyond individual experience and intentions (Hodges and Baron, 1992). Thus, explanatory power is not only given to what emerges as a

result of local coordination within an environment. By this ecological perspective, perception is not just an individual and extended phenomenon; it is also social and ecological. Hodges and Baron (1992) present a values-realisation theory that emphasises the moral dimension of conversing (Hodges, 2007a; 2007b; 2009; Hodges and Baron, 1992; Hodges and Geyer, 2006; Steffensen and Hodges, 2010). Using the perspective of Gibson's ecological psychology, Hodges (2007b) defines values as:

> the boundary constraints on ecosystems that define their dynamics and the directedness of organisms' activities within them. In their [Hodges and Baron, 1992] formulation, values underwrite the self-organizing constitution of niches (i.e., ways of life) that guide the selection, coordination, and revision of goals and affordances. In short, values have priority over goals, rather than being means for their realization. However, both accounts treat values as ontological realities that are fundamental, not reducible to biological processes, social conventions, or personal preferences. […] Values are multiple, heterarchical, dynamic, and legitimating constraints on actions. (Hodges, 2007b:590)

In placing values at the core of our human life-world, Hodges and Baron propose thinking in terms of a *value heterarchy* (Hodges and Baron, 1992). The concept presents values as multiple and non-hierarchical (Hodges, 2007a). We cannot *a priori* predict which values will be realised or which will be prioritised. There is no fixed order of values: for instance, in healthcare practice, rapidity may predominate in an emergency situation, while in other situations, values in terms of curing, alleviation, or caring may be realised. In healthcare practices, procedures, rules, and roles serve as cultural affordances for realising values. However, humans are not machines that follow context independent rules. Practitioners are living people who realise values by coordinating their signifying bodies (cf. Cowley et al., 2010) in dynamic and complex situations (Cowley 2010; Hodges, 2009). As Hodges (2007b) emphasises, conversing is about realising values. "The fundamental ecological task in acting and perceiving is to realize values. Social solidarity with those who speak to us and listen to us in caring ways is a crucial dimension of why and how we speak at all." (Hodges, 2007b: 598). By emphasising 'dialogue' weight falls on normative aspects: dialogue can realise values in action-perception cycles that are conducive both to caring relations between interlocutors and to problem-solving. From a values-realising perspective, caring renders possible shared understanding of morally appropriate activities. Values can be realised in several ways (Hodges, 2007a), despite the fact that there are no specific or hierarchical values connected to a dialogical practice.

Dialogical situations always unfold as a values-realising balance between various physical, moral and social constraints (Hodges, 2007a). Values are easiest identified when a cognitive system is stressed, e.g. when individuals are confronted with several tasks and need to make rapid decisions. Thus, using values-realising theory in the analysis of real-life cognitive tasks shows how individuals orchestrate multiple intentions, purposes, and targets over time. As such, values are non-local constraints on local coordination, and the theory has its strengths in the examination of how chaos and dilemmas are handled over time

3.5 Cognition

3.5.1 Cognitive event analysis and the local

The second perspective in the framework emphasises the cognitive features of interactivity. It combines cognitive event analysis (CEA) (Steffensen, 2013; Steffensen et al., forth) with distributed cognition (Hutchins, 1995a, 2014) to cover the rapid local coordination in relation to slower trans-situational conditions for cognition.

Timescales, which are rapid beyond the scope of human phenomenology, permeate human interaction. When turning to how the bio-cognitive aspects of interaction unfold, the method of CEA shows promise in moving beyond the social order. CEA builds on insights from distributed language (Cowley, 2011; Love, 2004) and distributed cognition (Hutchins, 1995a; Hollan et al., 2000). It is developed by, amongst others, Steffensen (2013), and it pays attention to how, in particular cases, sense-making within cognitive systems emerges as it solves problems with the aid of material artefacts (Steffensen, 2013; Steffensen et al., forth; Cowley and Nash, 2013; Uryu et al., 2014). The method is grounded in the humanities and builds on an ecological perspective to human interaction and cognition that favours a microscopic focus on inter-bodily dynamics, for instance, prosody (inspired by work of Cowley (1998; 2004)), gesture and movement (inspired by work of Goodwin (1994; 2000; 2002; 2007) and Gibson (1979/86)).

CEA finds its starting point in local coordination of flexible, adaptive behaviour. When such behaviour is constrained, it relates to what Anderson (2014) defines as the main cognitive problem of human behaviour, namely, deciding "what to do next" (Anderson, 2014:135). Problems emerge when immediate solutions to what to do next are suspended, requiring recalibration of the cognitive system (Steffensen et al., forth.). In my data, it is relevant to zoom in on events that are characterised by stress and constrained possibilities for action, for instance in situations where the unexpected happen. In that respect, CEA is highly useful. For instance, in a recent study (Steffensen et al., forth.), it is demonstrated how the method is apt for scrutinising the very specific problem space around an interruption of fluent action perception cycles to explain how individuals overcome the *suspended nexts* (Steffensen et al., forth.). Automatised action perception cycles are based on experience and they work until interruptions, fixations and suspended nexts force the agent to think and act differently. Much cognitive energy is allocated to testing new solutions, because the process lacks a known trajectory and useful experience that can be enacted *in situ*. Already in 1910 the philosopher John Dewey defined such suspended nexts as *forkedroad situations* and as the core conditions for reflective thinking:

> Thinking begins with in what may fairly enough be called a forkedroad situation, a situation which is ambiguous, which presents a dilemma, which proposes alternatives. As long as our activity glides smoothly along from one thing to another, or as long as we permit our imagination to entertain fancies at pleasure, there is no call for reflection. Difficulty or obstruction in the way of reaching a belief brings us, however, to a pause. […] Demand for the solution of a perplexity is the steadying and guiding factor in the entire process of reflection. Where there is no question of a problem to be solved or a difficulty to be surmounted, the course of suggestions flows on at random […] Thinking is not a case of spontaneous

> combustion; it does not occur on "general principles." There is something specific which occasions and evokes it. […] Reflective thinking, in short, means judgement suspended during further inquiry; and suspense is likely to be somewhat painful. (Dewey, 1910:11ff.)

When automaticity and habits are indecisive in a particular situation, a breakdown or a disturbance appears to individual(s) within the system and makes them think differently because the activity-system experiences (painful) constraints. When a flow is disrupted, one will look for a fixed viewpoint from which one can see new solutions and connections (Dewey, 1910). Moreover, a *forkedroad situation* affords a separation of processes into meaningful categories. According to Dewey, this is analogous to Heidegger's hammer example, which argues that we only experience a hammer *as* a hammer in the moment the system becomes dysfunctional: when the hammer breaks, hits one's finger, or something else changes the flow within the system (cf. Dewey, 1910).

In a somewhat similar vein, Steffensen (2013) highlights that what agents tend to do in such situations can be described as action perception cycles of solution-probing activities, rather than modelling of inner mental representations (Steffensen et al, forth.). At a practical analytical level, the method explores the cognitive trajectory of a system. A trajectory is a dynamical activity path that emerges as agents move through a problem space towards a cognitive result (Steffensen et al, forth.). The transition point defining this path can be characterised as an event. An event covers a change that emerges in the relation between agent and environment. Within the change process, multiple transition points emerge, but often just one or few points are: "pivotal for making this event happen. Such transition points are in CEA termed *event pivots* (Steffensen, 2013:201). An event pivot is thus functionally defined as a transition point which is a *conditio sine qua non* for identifying a segment of a cognitive trajectory as a specific (kind of) event" (Steffensen et al, forth.:15). In the following figure Steffensen et al., (forth.) has defined a five steps procedure in CEA:

Procedure	**Description**
Cognitive Event Identification	Identification of a cognitive event, typically an organism-initiated change in the layout of affordances in the organism-environment system, in a video record of a naturalistic or experimental data set. The event may be defined from an observer's or a participant's point of view
Event Pivot Identification	Identification of the critical transition point (or "phase transition") without which the cognitive event would not be an event

Data Annotation	Segmentation and annotation of (peri-pivotal) video sequence, using multiple (hierarchical or coordinated) tiers, with or without a constrained set of annotation values
Cognitive Trajectory Segmentation	Segmentation of video sequence into *functionally* and/or *behaviourally* defined phases
Cognitive Trajectory Analysis	Analysis of how specific segments of the cognitive trajectory (particularly the event pivot) are enabled by preceding segment and behavioural tendencies

Figure 3.3: Five steps of doing Cognitive Event Analysis (Steffensen et al., forth).

Whereas CEA allows for detailed investigations of local problem-solving (enabled and explained by non-local sense-making), its analytical focus remains on the microscopic dynamics of human interactivity. The bio-cognitive dynamics that are scrutinised emerge as changes in an overall cognitive system. While such changes may not necessarily be experienced as changes for the participants, they are important for the understanding of how errors are encountered and can be managed successfully both in the local situation and in future situations.

By drawing attention to other causal frames in local interaction, the stabilised, conventionalised and socially coordinated behaviours that emerge on slower timescales can support analyses of how and why practitioners manage problems as they do: for instance, how do they avoid getting overwhelmed, how do they cope with the unexpected, and what enables them to see new solutions or what prompts them to get out of a fixation bias? While these questions can be dealt with on various timescales, no single timescale allows for a comprehensive answer. In the following section, the distributed cognition perspective is introduced as a supplement that supports analysis of local cognitive operations with a non-local view that emphasises the trans-situational aspects of cognition.

3.5.2 Distributed cognition and the non-local

Instead of placing cognition within the brain, Hutchins proposes that meaning making be viewed as dynamic and embodied phenomena where brains, bodies, and world co-function (Hutchins, 1995a). Anderson (2003) takes this a step further by rejecting input-output models and the representational theory of mind of classic cognitive science. Instead cognition is seen as grounding co-existence with the environment. In that sense, cognition is embodied, embedded, and distributed. As mentioned in chapter 2, DC is useful to

understanding how more than the cognitive abilities of an individual enable cognition. By taking the environment as part of cognition, environmental richness in organising and structuring thinking becomes salient. Hutchins (1995a; 2014) describes how cognition is cultural, social and distributed. His perspective requires that cognitive analysis pays attention to the broader context in which problems are solved, decisions made etc. With emphasis on how culture and social processes influence cognition, DC pays attention to how slower timescales imbue local coordination. The way individuals solve problems depends on their cognitive history and what the context provides as useful anchor points to reduce cognitive overload. For instance, in local treatment-situations, health practitioners co-act and draw on external artefacts and procedures (products of earlier events) that form the basis for future events. As individuals engage, exploit, learn, and coordinate in action, interactivity thus functions as "the glue of cognition" (Kirsh, 2006) within a distributed cognitive system.

The qualities of a distributed cognitive system are obvious: people can solve problems that they could not have solved by themselves. Norman (1993) elaborates on the fact that we are not just dependent on others when discussing e.g. learning or cognition; we rely on material artefacts too: "The power of the unaided mind is highly overrated. Without external aids, memory, thought, and reasoning are all constrained. But human intelligence is highly flexible and adaptive, superb at inventing procedures and objects that overcome its own limits... it is things that make us smart." (Norman, 1993:43). However, Norman also emphasises that things can be designed in ways that tend to delay and prevent cognitive activities. Thus, the functions of artefacts and human brains are not fixed, and the quality of these resources depends on the way we use them to solve problems appropriately with regard to the goals to be achieved. While artefacts help us solve problems in some cases, they constrain problem-solving in others. A distributed cognitive system can be constituted in a way that makes cognition dysfunctional.

So with DC, emphasis falls on how material artefacts scaffold and constrain cognitive processes. As previously mentioned, DC is useful in the exploration of how a distributed cognitive system makes use of external structures in their work practice. Furthermore, the multi-temporality of cognition is underlined in the exploration of how the past affects real-time coordination. For an extensive discussion of DC, see chapter 2.

3.6 Interaction

3.6.1 Conversation analysis and the local

The third perspective that unveils a qualitative difference in human life relates to interaction. With conversation analysis (Sacks et al., 1974) attention is directed at the micro-sociological dimension of interaction. In this dissertation, the local organisation of interaction is investigated in relation to non-local perspectives of dialogism and organising conventions maintained over time through dialogical practices (Linell, 2007; 2009). CA's methodological apparatus can be useful in the exploration of the micro-sociological conduct of verbal interaction. Paradoxically, while one of CA's main strengths is its

insistence that contextual factors are only relevant through interactional orientation, this characteristic also becomes a shortcoming from an interactivity point-of-view. The interactivity-based framework thus uses CA on the local timescale and meshes such analysis with perspectives and theories related to other timescales, as the model shows.

With CA,[6] the analyses underline how sense-making is orchestrated through local coordination. By emphasising how, in verbal utterances, participants accomplish goals through linguistic micro-scale conversation, light is shed on how roles, power and respect *also* are socially constructed with language in action. When investigating such phenomena, the analyses make particular use or repair analysis to show how hesitation, pauses and rephrasing influence local achievement of goals, management of projects and interpersonal relations. Furthermore, the analyses focus on how participants are held accountable for actions, individually and as a team that co-construct a particular outcome.

Thus with CA it is somewhat possible to identify how professionals and patients coordinate by orienting to certain rules, norms and material structures that both facilitate and constrain diagnosing in local situations. While CA is restricted to analysis of social aspects of interaction, the interactivity-based framework acknowledges that there is more to interaction than what can be traced to the social interaction order. Furthermore, the social order is related to the trans-situational coordination that can be understood with theoretical perspectives of the non-local in the local, such as dialogism.

3.6.2 Dialogism and the non-local

The interactivity perspective has been critiqued as describing relational couplings within systems in rather scientific and dehumanising terms (cf. Linell, 2015). Theoretical perspectives that shape interactivity are influenced by bio-cognition and biosemiotics. Within these disciplines, the *organism* or the *animal* has been the central focus of analysis. The human being and its moral obligations in dialogue have not been emphasised in the adaption of these theories (Marková et al., 2008, Linell, 2013; 2015). By linking the biological prerequisites for human sense-making with theories that philosophise about what it means to be human, the bounded and dynamical aspect of human life is balanced in a dialogical way. Thus, in the analytical framework, the theories contribute to 1) emphasising the human of interactivity, 2) an understanding of how being human affects local coordination and 3) a link between slower timescales of social coordination and the rapid dynamics of local coordination.

Linell introduces *extended dialogism* and *dialogicality* as two important (meta)theoretical concepts for understanding human interaction and sense-making (Linell, 2009; 2015). Extended dialogism is an epistemological and ontological framework that considers human sense-making as a trans-situational phenomenon. Specifically, the dialogical nature of the living body is apparent in its ability to engage in real-time dialogue by enacting an

[6] For an extensive discussion of CA, see chapter 2.2.

embodied historicity of dialogues (Linell, 2015) and social coordination (Steffensen, 2012). As an epistemological framework, dialogism is concerned with how human beings make sense of the world in coaction with the world and others. The framework emphasises context, interaction, language, sense-making and 'the other' (Linell, 2009). "A definitional point in dialogism is the assumption that human nature and human life are constituted in interrelations with 'the other', that is, in *other-orientation*. […] Our action, thoughts and utterances are imbued with interdependencies with what others have done, are doing, and could be expected to do in the future" (Linell, 2009:13). The role of others is essential in dialogism, and the other is a complex character. Because people orient to and exploit ideas from previous situations as they interact with others, the non-local meshes with the local here-and-now (Linell, 2009, Bang and Døør, 2007). This multiple orientation is termed 'double dialogicality' and refers to individuals' complex histories of coordination, experiences and dialogues that imbue local coaction with a certain degree of intentionality: "Double dialogicality makes us see an act or utterance both in its singularity and in its wider sociocultural and historical belongingness" (Linell, 2009:53). Whereas non-local meaningful coordination is dialogically related to processes of local sense-makings, the notion of timescales becomes relevant in analysis: the analyst can orient to different dynamics of coordination. In that sense, double dialogicality implies an analytical focus toward 'remote audiences' (Linell, 2009:99). According to Linell (2009) 'third parties' as generalised others show up as perspectives, institutions or identities voiced by the interacting parties (Linell, 2009:103).

In this dissertation, theoretical concepts within the dialogism perspective, (e.g. communicative project, voiced others and sense-making (Linell, 2009; 2015)) are used to support the investigations and interpretations of sociocultural dynamics in local interaction in order to link multiple timescales in the explanation of adaptive flexible behaviour of a cognitive system. Dialogism connects a bundle of various dialogical approaches that emphasise interaction, context sensitivity and sense-making.

3.7 Conclusion: the non-local in the local

The interactivity-based framework integrates multiple timescales that mesh in the situated here-and-now and are identified as different dynamics that generate specific behavioural trajectories. These dynamical trajectories are explored and explained with different approaches, visualised in figure 3.2. As such, the methods shape and inform theories about how a cognitive system works and the theories systematically guide and validate concrete interpretations.

If it was reasonable to state that the non-local is unobservable and the local is observable, one could rely on theories as dialogism to explain the causal affect of the historicity of individuals in local interaction. However, the complexity of human interactivity does not follow such logic. Often, much in situated interaction is implicit for observers and much history and experience is shared explicitly. Thus, the empirical analytical method of CEA for instance, can reveal how local utterances connect with history, norms and previous

experience. That means that the approaches inform both what is made explicit and what remains implicit, but there are some processes that take on a black box aspect. In other words, theory cannot account for all bio-cognitive processes in a reliable way, and neither can observation. Thus, as an additional methodological initiative, in some cases, interviews are made with the involved after a diagnostic situation in order to unveil their on-action reflection of their phenomenological in-action experience. While such interviews do not necessarily provide 'true' information about previous events, they cover what individuals emphasise about their experience from a subjective first-person perspective. Within the analytical framework, theories and perspectives are included to support the immediately unobservable - for instance when people implicitly or explicitly draw on personal and professional expertise or sociocultural experience, and to support, via its axiomatic assumptions, investigations of how and why bio-mechanics and the moral dimension of human behaviour influence outputs (for instance distributed language (Cowley, 2011; Thibault, 2011; Love, 2004; Steffensen, 2011), dialogism (Linell, 2005; 2007; 2009; 2015) and values realisation (Hodges, 2007a; 2007b; 2009; Baron and Hodges, 1992; Steffensen and Hodges, 2010)).

Depending on one's research question, different approaches will prove more or less relevant. If suitable, one can choose to zoom in on how social orderliness affects outcome or how inter-bodily dynamics constrain functional coordination. The different approaches have their strengths and shortcomings on different temporal scales, as they deal with different features of interactivity. In the end, what happens (and how results are achieved) is enabled by the emergent possibilities that arise when local situational dynamics mesh with non-local constraints (individual, social, institutional), with phenomenological experience of what is going on, and with the materiality of the situation. In an interactivity-based approach, the key is to identify the enabling conditions for human action. To do so, the analytical framework takes its starting point in the enchronic timescale and pivots on how cognitive events are managed to make the system reach a diagnosis. It searches real-time cognitive trajectories in order to identify crucial moments for (dys)functional task performance. By scrutinising such moments, attention is given to slow cultural scales and rapid pico-scales to explain how coordination affects the achievement of results that have consequences for the overall outcome. The specific analytical focus of each chapter is outlined in detail in the beginning of each chapter.

4. Research design

> The phrase "cognition in the wild" refers to human cognition in its natural habitat - that is, to naturally occurring culturally constituted human activity […]. I hope to evoke with this metaphor a sense of an ecology of thinking in which human cognition interacts with an environment rich in organizing resources […]. There is a common misconception among cognitive scientists, especially those who do their work in laboratory settings, that research conducted outside the laboratory is necessarily "applied" work. I will argue in what follows that there are many excellent reasons to look at the "real world" that are not concerned with hoped-for applications of the research findings […]. Pure research on the nature of real cognitive practices is needed.
>
> - Edwin Hutchins, (1995a: xiii-xiv)

4.1 Designing a non-experimental research study: dealing with naturalistic habitats

This chapter emphasises the basic reflections behind the research design. It begins with a discussion of experimental versus non-experimental studies in relation to the ecological framework of the project. Second, the chapter presents the case study that constitutes the basis for analyses and it describes the process of doing cognitive ethnography within a Danish hospital. The ethnographic study covers processes of data collection, data presentation, research ethics and coding. Based on the initial coding process, six themes are defined and further investigated as hypothetical organising principles of the subsequent analyses (chapter 5-10).

Based on the research question, an important methodological question is: how do I structure and design the research project in a way that meets the need for explorative

investigations of interactivity in an ecological setting? As inter-bodily dynamics, for instance, play out on a very rapid timescale, often beyond our phenomenological experience, they can only be systematically captured in digital recordings. While the review (see chapter 2) unveiled that the amount of studies using video-ethnography advances, the video-data are not used carefully in many analyses. Thus, in spite of the growing number of studies using video-observation to explore moment-to-moment interaction (for instance Heath et al., 2010; Goodwin 1994, 2007), contributions based on video-recordings of real-life within the field of emergency medicine are still low:

> More research is needed to determine why health care professionals differ in their perceptions of teams and their contributions of teamwork skills to successful communication and performance […]. It appears also that the bulk of this work may lie beyond these clinician surveys and video-analysis may provide additional insights. (Mackenzie and Xiao 2012: 524)

Video-observations of real-life situations in emergency medicine are underutilised (Mackenzie and Xiao 2003; Mackenzie and Xiao 2012). According to Mackenzie and Xiao (2012), this is problematic since our knowledge of medical performance in real and natural, complex, dynamic, ever-changing emergency situations is very limited.

This project points to the fact that the field of emergency medicine lacks a comprehensive understanding of the complex enabling conditions for human interactivity, which is related to multiple time-scales spanning from here-and-now dynamics, sociocultural norms and habits to organisational structures. Such investigation yields fine-grained analyses of the positive as well as negative feedback mechanisms in real-life interaction and it is oriented towards problem finding by asking 'what happens' prior to problem-solving. In that respect the design should afford understandings of the nature of medical performance, rather than be based upon pre-defined hypotheses of how practitioners are constrained in task performances.

Following Hutchins' suggestion, grounding cognitive research in the domain of natural, real life cognitive events, makes one immediately aware of the methodological challenges that follow such a decision. To exchange the laboratory setting for a natural habitat of a sociocultural practice entails considerable repercussions for the way the research design should be framed (Hutchins, 1995a). It invites more ecological and ethnographic research forms that favour non-experimental, though resource demanding, research designs (Streeck et al., 2011). Experimental designs are driven by hypotheses that cause the researcher to suppose 1) what the problem is, 2) how it can be identified, 3) which variables are needed to test specific cognitive abilities and 4) how experimental results contribute to an understanding of how people solve problems in real-life situations. Where experimental research carried out in laboratories has other strengths (strictly-controlled and demarcated tests and measurements), they obviously tell different things about a given phenomenon, *or* they investigate different kinds of cognitive processes:

> the conventional approach in which perception, decision making, and action are treated as functionally distinct elements within the closed-loop system will not be appropriate to the study

> of coordination. This conclusion is supported by recent work in naturalistic decision making. This research has indicated that the decision making of experts in natural environments is intimately linked to perception (or recognitional processes) and that laboratory research in which decision making is uncoupled from perception has little value for predicting performance in these natural settings. (Flach, 1999: 122)

4.1.1 A case study of medical emergency teams

In cooperation with a Danish hospital (Køge Hospital) a case study was initiated to gather detailed and systematic information from the organisation. Berg (2004) underlines that case study methods "involve systematically gathering enough information about a particular person, social setting, event, or group to permit the researcher to effectively understand how the subject operates or functions" (Berg, 2004:251). The emergency ward at Køge Hospital served as the organisational setting in which I collected enough relevant data to investigate the outlined research questions. In the following, a brief description of the organisational setting is outlined.

This project is an independent research project established in cooperation with the emergency ward at Køge Hospital. The Department of emergency medicine at Køge Hospital receives 47,000 patients annually, of which 30,000 are treated for minor casualties (small burns, strains, etc.) and then discharged. Of the remaining 17,000 patients, 2,000 are high-emergency cases that demand treatment by a multi-disciplinary emergency team, a resuscitation team or a trauma team. For ethical reasons, trauma cases are excluded from the project. Small teams of 1-2 doctors and 1-2 nurses treat the remaining 15,000 patients; these patients are triaged, given an initial treatment, and referred to further treatment, either at home, in a specific specialist ward or in the department's observation beds.

The case study uses cognitive ethnography as a methodological framework for data collection: Ethnography is defined as:

> a particular method or set of methods which in its most characteristic form […] involves the ethnographer participating overtly or covertly in people's daily lives for an extended period of time, watching what happens, listening to what is said, asking questions – in fact, collecting whatever data are available to throw light on the issues that are the focus of research. (Hammersley and Atkinson, 1995:1)

Traditional ethnographers are interested in how members of a group see society and construct their own perspective and reality through that particular vision. Ethnomethodology is more attentive to how members *do* things, especially through language use (Seale, 2012:247). However, an interactivity-based framework pursues a *naturalised* view on what happens. The ethnomethodological approach is concerned with the reality that people construct as well as the reality in which they are embedded. Observation of multiple gradations are needed to account for interactivity, or in other terms the complex pool of what people say, do, think, feel, accomplish, etc.

This cognitive ethnographic fieldwork study involves a combination of methods ranging

from observational research such as video-observation and participant observation as well as observing material culture over time and collecting qualitative interviews (Seale, 2012:163). The design allows for a dual focus on both the micro and macro scale of interactivity in the medical settings as well as a registration of an experienced and observed level of behaviour and sense-making. The study's overall focus is on the micro timescale that includes what happens in real-time by the use of video-observation. Thus, on a micro scale it investigates how professionals accomplish cognitive results and especially how fluid medical teams integrate skills in interaction, cognition and teamwork. On a macro scale it investigates how the structural and cultural organisation of these teams influence cognitive outputs. Both dimensions are designed to use cognitive ethnographic fieldwork (Hutchins and Nomura 2011) in generating a *thick description* (Geertz, 1973) or investigation of what happens in the light of the overall cognitive ecology (Hutchins, 2014) and the organisational culture of the ward. The structure of the cognitive fieldwork is twofold. The project uses participant observation to observe the material culture systematically and intensively over a two-month period. After this two-month period, it uses video-observation, including interview gathering over a one-month period. These processes are elaborated in the following.

4.2 Data collection

4.2.1 Participant observation

As part of the ethnographic study I participated as an observer. A two months long observation study was conducted to provide general knowledge about the organisation, its practitioners, procedures, norms etc. At this scale video-observations are supplemented by observations of the physical surroundings and affordances of the departments, observations of everyday life activities in the department, both formal meetings and informal gatherings, which will be elaborated upon below. These observations and daily chats map the cultural dynamics of the ward, as the practitioners employed there phenomenologically experience these. Eventually, I came to understand how, in particular situations, cultural and organisational dynamics that operated beyond the individuals were enacted.

I was intrigued by the overall efficiency at the ward, the sublime coordination in the medical team as well as the frustration I experienced when something went wrong. To gain a deeper understanding of the underlying mechanisms in these processes, I initiated systematic, detailed observations that covered various data: standard procedures (how to dress, speak and follow instructions in diagnostic processes), work procedures in diagnostic events (writing the electronic medical record, physical examination of the patient, using the electronic patient board etc.) and the daily workflow and patient flow[7]. Further, I participated in numerous medical conference meetings and de-briefings concerning treatment situations. I followed a primary doctor during his workday to

[7] Written instructions and guidelines for various professions were collected. Moreover, other data such as statistics on workload at the ward, patient-flows etc. were incorporated in my field notes.

understand the division of labour, the level of resources available at the ward, the multiple formal team constellations a healthcare practitioner engages in, and the tasks that need to be completed during a workday. Moreover, I received verbal and written information about overall procedures spanning from medical guidelines and instructions, hygiene procedures, an introduction on how the electronic patient board is managed, what the procedures are for calls from various sources, e.g. 112 (911/999). The observations resulted in written field-notes about general work procedures, rules, educational programmes and team constellations.

At regular intervals the ward receives newly educated doctors. I participated in a general introduction course for new doctors. Likewise, I was given a medical uniform, I learned to give first aid, and I participated as an observer in a number of different treatment situations, where I was introduced to the techniques the medical teams used in diagnostic situations. The intention was to provide me with just enough knowledge of what was expected from the professionals in specific treatment situations that I was recording. My lack of medical and practice specific knowledge prompted me to ask naïve and clarifying questions that challenged fundamental assumptions guiding their work practice. To get a first impression of the workflow, I participated in day and night shifts, had lunch with the healthcare practitioners and often discussed the project with secretaries, nurses, doctors, paramedics and patients. I was soon treated as an employee and the staff often forgot that I was 'just' a researcher and were keen on discussing particular medical issues with me. Paraphrasing Becker (1963), I became a specific kind of practitioner who blended in at the ward.

This part of the study investigated how a cognitive system exploits organisational and cultural constraints (e.g. decision structures, role hierarchies, cultural norms and habits) and, by extension, how they influence how people speak and gesture as they choose between actions by orienting to material resources and organisational routines. The results have explanatory power in the investigations of how non-local dynamics that relate to, for instance, role hierarchies, norms and informal rules related to work practice etc. mesh with situated dynamics in local interaction. Methodologically, this part of the project exploits Connolly's (2006) underdeveloped observation that the cultural dynamics of what Bourdieu calls a *habitus* (Bourdieu, 1977) can be studied as part of distributed cognition. Beside invaluable knowledge about sociocultural dynamics, the aims were to gain trust and understanding amongst the employees and clear the way for regular video observations. This primary observation study provided me with an authority to investigate naturalistic situations first hand. The ethnographic fieldwork opened up for a possibility to conduct the research project in a trustful relationship with the organisation, but it also provided me with invaluable knowledge about the slower timescales that shape local situational behaviour.

The ethnographic fieldwork provided the warrant for proper interpretation and a basis for optimal video-observation. I aimed for a fluid transition between participant observation and video-observation. The intention was to accomplish as trustful, natural and relaxed video-recordings as possible.

4.2.2 Video-observation

The cognitive ethnographic fieldwork further included video-observations and qualitative semi-structured interviews. Within the tradition of ethnomethodology, micro-ethnography and cognitive anthropology, video-observation is a commonly used method for investigating embodied interaction in general (Streeck et al., 2011, Heath, 2002; Mondada, 2008; Goodwin, 2007). Because video-observation serves as a framework for holistic analysis of interaction involving more than pure verbal utterances (Streeck et al., 2011, Goodwin, 2000a; 2002; 2007), it has obvious advantages. It produces data that serve as a permanent source for documenting and it allows for rich detailed analysis as well as for unlimited reviews of what happens. The approach allows for results based on evidence rather than (faulty) memory. Indirect data in the form of recalled, past incidents has limited value when it comes to naturalistic descriptions. Recorded data overcomes potential biases in the retrospective construction of past events (cf. Mackenzie and Xiao 2012:525).

Specifically, 17 diagnostic treatment situations were video-recorded with up to three cameras over a month. One of the cameras was handheld to cover blind angles or zoom in on specific aspects. I video-recorded alternately at two wards: a sub-emergency and an acute emergency ward. The set-up is illustrated below.

Angle 1

Angle 2

Angle 3

Handheld movable camera

As part of the ethnographic work, I attempted to cover the general workflow and patient flow at the ward. A recording plan was made in order to secure a broad section of treatment situations. Multiple variables were taken into consideration and the plan ensured that the recordings embraced an accurate representation of diagnostic situations in relation to (*a*) night and day shifts, (*b*) different workdays, (*c*) novice and experienced practitioners, and (*d*) emergent and sub-emergent patients.

I was present during all video-recordings as a silent observer (Phellas et al., 2012) and I took field-notes during all sessions.[8] Ideally, a whole treatment situation was recorded from the moment the medical team waits for the patient to arrive (911 calls) or from the moment the patient enters the ward and up until the doctor informs the patient about future scenarios (hospitalisation at another specialist unit, patient handover to another hospital or returning home). Unfortunately, some recordings are incomplete in length (for instance, in cases where the patient arrives before it has been reported to the key personnel at the ward). However, overall, the recordings contain coherent, diagnostic situations.

The medical team includes the specific configuration of medical practitioners – in the widest sense (e.g. doctors, nurses, porters, administrative workers, medical students, lab and x-ray workers, paramedics, police, public health and safety workers) – who deal with the patient. Beside the medical team, a recording includes the patient, and in some cases the patient's relative(s).

To supplement the analysis of what happened in diagnostic and treatment situations, I interviewed key practitioners afterwards when possible. The qualitative interviews were highly flexible and loosely structured and used structured free recall (Phellas et al., 2012), which encouraged the participant to talk freely about their own immediate view and reflection on a given diagnostic situation. Qualitative interviews are particularly useful, as a method for accessing a subject's own life world, which includes a set of beliefs, values and attitudes (Seale, 2012:209). As values form and affect the reflective processes and phenomenological experience, it becomes important not only to define what practitioners do and think *in situ*, but also how they make sense of a situation retrospectively. Often, their reflections diverge from analysis of the actual performance (see also Pedersen 2010, 2012), which will be elaborated in the analyses. Understanding this discrepancy is important to understand how culture is maintained and develops. The perceptions - or the practitioners' own perspectives - were compared with results based on systematic, detailed analysis derived from an observational perspective. It is, thus, in the light of this frequent inconsistency, that the key to learning is hiding.

In total, the project ended up with a large amount of rich data. The project uses, as primary data; video-recordings and as secondary data; fieldwork notebooks, interview data, and organisational material from the ward. The secondary data serves as a prerequisite for understanding how the sociocultural non-situational dynamics mesh with situated action. To gain knowledge about the subject and the work practice, and to understand how

[8] Momentarily I would place the handheld camera on a table or a chair, so I could write down my observations in a diary.

sociocultural constraints are enacted in situated interaction, I expanded video-ethnography to a broader study of the overall work setting.

4.2.3 Research ethics and anonymity

Before the research study was initiated, the chief physician for education, the executive chief physician and the executive head nurse at the department, and I formed a consultant committee. The aim was to discuss and manage practical, ethical and legal issues in corporation. A 70 pages long research protocol that covered relevant practical, ethical and legal aspects of the project as well as relevant documents, e.g. documents concerning written consent, information papers to all involved participants were worked out by me and sent to relevant key practitioners at the hospital. The project was registered with the Danish Data Protection Agency and the National Ethical Committee was informed about the project. After the project was registered, all departments at the hospital were informed verbally at department meetings as well as in writing, for instance on information boards and on the Intranet. Furthermore, health and service workers, and the ambulance service were informed about the project, as the cameras would be recording their arrival with patients. In such cases it was only possible to get retroactive consent from the involved parties afterwards.

I was responsible for providing informed written and verbal consent from all recorded participants. In relation to patients, I asked for permission in advance when possible. If they were too ill when they arrived, I asked afterwards. If they did not want to participate, I deleted the data immediately. If a patient died during the recordings, the data were also destroyed immediately. I did not record patients under the age of 18. As a silent observer I was present during all recordings and took field-notes, collected written consent from all participants involved and managed all technical issues.

The data made public are anonymised and all patient and practitioner identifiers are removed. Data are only kept physically secure under a triple set of locks. To preserve confidentiality the management could under no circumstances gain access to the recordings. Such access was a big concern amongst the practitioners before they gave consent. The project uses non-invasive methods only and the patients are not contacted after they have been recorded. They were informed that they could contact me with questions or regret their participation at any time as long as their data had not yet been made public, though this matter only came up once.

During the three months I spent at the hospital, I built good rapport with many of the practitioners, and I am aware of how trust, friendship and personal engagement in the daily work could bias my conclusions. However, it is my conviction that there have not been any problems, since all data are anonymised and no parties are being personally confronted with either good or bad behaviour. The aim is to achieve a general knowledge of working dynamics to better understand the systemic dynamics that constrain effective treatment, rather than create a list of specific practitioners that may turn out to perform in an (in)effective manner within particular situations.

4.3 Coding: a two-phased inductive approach

While the project has a clear aim of understanding how practitioners encounter (potential) critical moments and how they avoid getting into critical situations, there is no *a priori* determination of which particular issues may be relevant to study further. There is an interest in negative and positive feedback mechanisms within teams, but no decisive knowledge exists of what exactly defines a positive or negative feedback mechanism at a concrete, practical level within this field (see chapter 1). Thus, particular cases of interest are suggested empirically from the data. An important remark on identifying these cases will be made.

As coaction relies on direct action and perception, it consequently operates with processes without inherent starts and ends. Interestingly, several approaches to spoken language and cognition treat their object of investigation as a fixed and demarcated object. However: "a special sense impression clearly ceases when the sensory excitation ends, but a perception does not. It does not become a memory after a certain length of time. A perception, in fact, does not *have* an end. Perceiving goes on." (Gibson, 1979/86:253). Gibson continues to argue that verbal tenses bias our understanding of time and perception. An epistemological distinction is simply confused for an ontological process (Gibson, 1979/86:253). When activities are disrupted into situations or events, we need to define a beginning and an end with the use of external criteria (Gibson, 1979/86:101).

The coding process is an interpretive technique that helps organise, structure and prepare the video-data for detailed analysis based on such external criteria (Seale, 2012). In this case, the overall coding process is an iterative process that uses a two-phased inductive approach, only framed by an external criterion of function in relation to work tasks: how cognitive events are managed in relation to the overall task.

The educational staff at the ward explained to me how they, in the ward, work with well-defined hypotheses of what develops as erroneous and successful activities. At the same time the healthcare practitioners explicitly uttered a frustration of not getting past the surface of what happens beyond their immediate level of reflection. For instance, they had the feeling that working in ad hoc teams was a huge challenge and often caused time delays, frustration etc. However, the enabling conditions or the feedback mechanisms within the system, were less easy to identify. First, this calls for thorough investigations of the pico-scale dynamics that lead to errors and successes beyond that which teams experience and are able to explain. Second, to get beyond pre-established hypotheses of which situations are relevant to scrutinise further, I started with an exclusively data-driven approach to coding. The first categorisation I made represented - as objectively as possible - what happened and this organised the data into large categorical chunks labelled with categories that were used within the dataset rather than theoretical labels. This process gave an overview of the dataset with minimal interpretation. The coding process established an idea of the general patterns across the dataset with notifications of relevant general pivots that needed to be investigated further.

Roughly, the coding process is divided into two main phases. However, the process is fluid and iterative and can be illustrated in the following figure, inspired by Seale (2012). The table and its theoretical concepts are elaborated subsequently.

Two-phased inductive coding process 1) coding for concepts/categories, tasks and subthemes via open coding 2) linking task-based events and subthemes to emerging hypotheses
1 - **Immersion in the data** (notes and comments) - **Identify recurring and important categories** (making connections within the dataset) - **Indexing in coding scheme** (Simplification through categorising. Enlisting the data chunks into similar task-based events and subthemes. Defining topics for further analysis to narrow down the amount of data remarkably)
2 - **Charting, hypotheses generation and final selection** (hypotheses emerge when cross-relating the most salient task-based events and subthemes in the coding scheme. The thematically-developed hypotheses serve as an organising principle for analyses)

Initially, the first phase included a basic and rough overview of the enormous corpus of raw data material. As a starting point, I viewed all recordings several times and from the various angles they were recorded. Most recordings were recorded with three cameras, and at a minimum with two. One of the cameras was handheld. First, the data were trimmed down by a criterion of overall usefulness: for instance acceptable visual and audio quality. The data were initially reduced to include 14 treatment situations, which amounted to 13

hours times two or three depending on the number of cameras used. The recordings varied in length, degree of emergency, practitioner experience, and team or individual performance.

After the rough viewing, I identified and connected recurring and salient categories within the dataset. The 14 treatment situations were analysed into small, demarcated task-based events that were inductively defined from watching how multiple elements in diagnostic processes and pre-treatment contribute to achieving the overall goal. In other words it is *a task-based criterion that determines an activity as a local nested event within the overall diagnostic situation*. *Second, a criterion of cognitive function determines how a task includes subthemes: for instance as tasks are permeated with interruptions, hesitation etc.*

To begin with, the coding scheme was broad and the coding categories were rather incomparable across the dataset as it used a data-specific language via open coding[9] to label chunks of data. After coding all 13 hours by this approach, the chunks and codes were interpreted and reduced by the identification of recurring task-based events and subthemes, for instance physical examination and documentation tasks. The categories were boiled down to a few overarching and relevant tasks to simplify and limit the number of thematic focus points. Also, this simplification made comparisons across the dataset possible. Specifically, 22 categories represented a specific medical or interpersonal task or task-related activity. The categories were used for framing episodes into delimited task-based events or subthemes within the overall interactivity trajectory that defines an overall and shared project: diagnostic practices and pre-treatment of patients. Each category is numbered from 1-22. For an overview, see table 4.1[10] below:

#	**Task-based events and subthemes**	**Explanations**	**Number of instances**
1	Measuring medical values	The healthcare practitioner measures the patient's medical values (blood pressure, oxygen saturation etc.)	43
2	History taking	The healthcare practitioner (often the doctor) asks for information, (medical history etc.)	28
3	Physical examination	The healthcare practitioner examines the patient	27
4	Summarising (to patient)	The healthcare practitioner summarises the situation so the patient is aware of the	20

[9] Essentially open coding means to break data into conceptual components (Strauss and Corbin, 1990). This process allows data to be grouped and organised.

[10] The table is a simplified overview of the categories used in the detailed coding scheme that encompasses explicit references to the video-data and detailed information about the involved practitioners.

		progression, diagnosis etc.	
5	Information about future scenarios (to patient)	The doctor informs the patient about possible future scenarios and recommendations for further treatment etc.	17
6	Documentation in the electronic medical record	The healthcare practitioner keys information into the medical record	38
7	Pre-treatment	The healthcare practitioner initiates a pre-treatment (medication, oxygen etc.)	12
8	Reading and interpretation of documents	The healthcare practitioner reads information from relevant textual documents, medical record etc.	2 *
9	Professional discussion	Healthcare practitioners discuss the clinical and medical situation. This includes evaluation and hypothesis-generation about the patient's medical condition	12
10	Nursing	The healthcare practitioner (often the nurse) handles clinical and interpersonal trifles (undresses the patient, brings water and food to the patient etc.)	9
11	Patient handover	The medical team receives the patient from paramedics and ambulance personnel	4
12	Examination by a doctor from another specialty ward	A doctor from another specialty ward examines the patient	2
13	Small talk	Small talk within the medical team and with the patient	8
14	Technical issues	Problems related to technical issues (the computer freezes, the phone is low on battery etc.)	2
15	Observing medical measurements	The practitioner observes the patient's medical measurements	app. 50**
16	Reporting	The healthcare practitioner reports a patient to a specific medical speciality at another hospital unit	3
17	Interruption	The medical team or the healthcare practitioner is being interrupted	app. 30**
18	Closing	The healthcare practitioner finishes the interaction with the patient and leaves	13
19	Team performance	The healthcare practitioners perform a shared medical or clinical task through implicit or explicit coordination	6
20	Hesitation	The healthcare practitioner hesitates	1*
21	Explicating	The healthcare practitioner informs the patient	2

	procedure	about what he is doing (for instance, that he is going to key information into the electronic medical record)	
22	Patient or relative interruption	A patient or his relative(s) interrupt(s) the healthcare practitioner	4

Table 4.1 Coding scheme

**Often practitioners briefly leafs through the medical record or hesitates during task performance, however, the annotations in the coding scheme cover the main activity that the practitioner/team performs. In cases of, for instance hesitation or team performance, situations of noticeable instances are annotated.*

***The number of instances in row 15 and 17 are approximate annotations as I lost access to the data (see preface).*

The coding scheme does *not* contain information on whether or not the doctor and nurse are novices or highly experienced, the degree of emergency, duration of each event and overall treatment situation as well as particular professional roles a team constellation includes. This information is added in the field-notes and it is explicated where relevant in the analyses.

In total 333 occurrences were identified in the coding scheme. The prevalence of some tasks is related to obligatory procedures that need to be followed. For instance, no patient can enter the ward without having relevant medical values measured or without providing a medical narrative. Other tasks are tokens of optional or rare instances. For instance: 'reading and interpretation of documents' (row 8) or 'technical issues' (row 14). Apparently, there is no pattern in the way activities are completed and the number of practitioners involved except for 'professional discussion' (row 9) and 'team performance' (row 19). In 55.3% of all cases, one practitioner alone completes a task. In 44.7% of the cases the task is performed with two or more practitioners present at the same time. The original coding scheme further includes qualitative comments, which gives a solid basis for classifying diagnostic situations into procedural events alongside more informal and interpersonal events. Additionally, it gives an indication of relevant pivots within the overall flow of interactivity that need to be scrutinised further in the analysis. As the coding scheme opens for an overview of 'what happens,' it unveils that some tasks are procedural and highly frequent but rather unproblematic, e.g. 'measuring medical values' (row 1) even though several interruptions occur during this task performance - whereas other procedural tasks are managed with more difficulty, e.g. 'documentation in the electronic medical record' (row 6). Finally, other unique instances (e.g. row 17 and 22) encompass interesting information on how the unexpected is dealt with in the situation. Thus, the coding of various tasks brings forth an overall pattern of procedural and particular episodes within diagnostic events and it shines light on some aspects that need to be investigated further in analysis.

4.3.1 Hypotheses and event identification

Interpreted on the basis of the comparisons between the comments and annotations across the coding scheme, the most salient tasks that relate to the overall research question were scrutinised further. During this process, hypotheses about how cognitive and interactional aspects related to successful and less successful events emerged.

The hypotheses relate to how cognitive and interactional aspects in emergency situations constrain or support the emergence of error cycles. To illustrate this point, an example is given. For instance, in situations where material tools provide measurements that diverge from explanations coming from the patient, different strategies for handling this discrepancy were identified in the dataset. Some practitioners became biased by objective representations and they immediately prioritised medical guidelines over the patient's subjective first-hand explanations. Others contained the inconsistency and adapted flexibly as they balanced hard facts with "hard narratives" and sorted out what the discrepancy was about. This difference led to a hypothesis about medical expertise: *guidelines, medical procedures and material artefacts both scaffold and constrain diagnostic processes. The crucial point in successful diagnosis and treatment is to know when, and when not, to rely on rules and artefacts as aiding resources.*

Multiple hypotheses were generated and related to positive or negative feedback mechanisms that needed further attention. The analytical chapters thus, investigate possibilities and challenges in diagnostic processes and relate these results to the hypotheses generated. Thus, based on the initial coding process, the following six themes were investigated further as hypothetical organising principles of the analyses: (*a*) medical visual systems; (*b*) interruptions; (*c*) diagnostic procedures; (*d*) medical cultural dynamics; (*e*) sense-making in teams and (*f*) writing the electronic medical record.

Each chapter, thus, focuses on a thematic aspect related to the systemic function of cognition and at an overall level, the analytical chapters contribute to the overall investigation of the overall research question. Each chapter shows the diversity of enabling conditions in the interactive social practice of human errors in emergency medicine.

4.4 Data presentation

The analysis uses video-data to examine the real-time dynamics of medical cognition. The rich corpus of audio-visual data needs to be transformed into meaningful representations on paper. As the analysis deals with events played out on very rapid timescales, transcriptions of verbal utterances require a detailed and well-developed transcription method that accounts for the various dynamics in verbal utterances. This project applies the transcription system developed by Gail Jefferson for the analysis of conversation (Jefferson, 1983; 1985; 2005). Some basic elements from the transcription system that are used in this dissertation are shown in the table below:

Transcription system	
CAPITAL LETTERS	Indicate remarkable loudness of verbal utterances
Degree signs around a word, e.g. °hi°	Illustrate verbal utterances articulated in a special low tone of voice
Left square bracket [	Illustrates the onset of overlapping verbal utterances
Numbers in closed parentheses (1.2)	Specify the length of silence in seconds and tenths of seconds
(.)	Micro pause (<0.2 seconds)
=	Latched talk/rush through.
Underlined words or sounds	Indicate if utterances are articulated with a special emphasis. In the second example prosodic emphasis
Ascending or descending arrows ↑↓	Illustrate rising or falling intonation
Pro:::longation	Indicates prolongation of preceding sound
.	Stopping fall in tone
.hh	Hearable in-breath
hh	Hearable out-breath
(xxx)	Non-audible speech
(laugh)	Non-verbal utterances
[comment]	Transcriber's comment

Table 4.2 Transcription system

In the transcriptions as well as in the figures, *D* and *P* are abbreviations for *doctor* and *patient* respectively. Inspired by Streeck (2008) and Goodwin (2014), amongst others, I apply edited pictures of the participants within the text to visualise embodiments in action. Non-verbal utterances are either visualised by pictures inserted in the text document or they are marked in the transcription followed by an explanation in a footnote. The major challenge is to visualise movements and the dynamical flow of small-scale changes. However, for lack of anything better, a gallery of static representations are used to indicate such rapid changes, and they are often supported by markings, verbal explanations etc.

Different software programs were used to edit, annotate and present the data. All pictures are edited in Photoshop. The editing includes (*a*) blurring of the practitioners' and patients' faces (due to ethical and legal concerns), (*b*) the use of arrows to indicate gaze and movements and (*c*) other visual markers to direct attention to a specific element in the picture. The annotation tool ELAN[11] is used to annotate multiple and simultaneous dynamics in interactivity. Before a task is investigated in detail, data is imported into the

[11] ELAN is a professional annotation tool developed by researches at the Max Planck Institute for Psycholinguistics, The Language Archive, Nijmegen, The Netherlands. It is developed for the creation of complex annotations on visual data (Sloetjes and Wittenburg, 2008).

program that allows for precise annotation of simultaneous actions, including verbal and non-verbal actions, such as: gaze, gesture, body movement, verbal utterance, activity type, interruptions as the most common tiers. The ELAN annotation tool enhances the analysis process and ensures exact measurements of multiple, overlapping actions in time, for instance a team's gestures and gaze orientation during verbal utterances.

After the annotation process, relevant events from the interactivity trajectory were chosen for further analyses primarily by the use of CEA. As mentioned above, CEA operates with an event trajectory that illuminates relevant event pivots. The layout of CEA is adopted in the analyses (see Steffensen et al., forth.; Steffensen, 2013.). In one case (see chapter 9.2), the computer software Praat,[12] which was invented for analysis of speech in phonetics, was used to annotate the exact measurement of vocal pitch attractors. These measurements are visualised in the text with the aid of Praat tools.

4.5 The interactivity-based framework: analytical procedures

Having introduced the field of human errors, human interaction and cognition, and the interactivity-based framework, I now present the analytical procedures that organise the structure of the following analyses. Depending on the temporal ranges that are relevant in the investigation of the topic (sociocultural dynamics, local interruptions of cognitive task performance etc.), the analyses draw on varies perspectives and timescales (cf. 3.3 and figure 3.2). The ambition with the analyses is to investigate particular situations to gain a deeper understanding of enabling conditions for proper and erroneous cognition in its widest sense. In various settings (different team compositions, levels of expertise, level of medical acuteness etc.) practitioners either perform functionally or dysfunctionally, and this dissertation aims for descriptions that explain how such different trajectories emerge. However, there *are* cases where tendencies are suggested. Such tendencies stem from relating particular results to information within the detailed coding scheme; for instance when a certain interaction strategy is related to practitioners' level of expertise and skill. Acknowledging the limitations of generalisation based on the relatively few recordings, I point to *tendencies* and areas that yield further investigations to support the claims and hypotheses set out.

As stated in chapter 3 the research questions cannot be fully answered by applying any single analytical method within linguistics, cognitive science, or interaction analysis. Thus, the project's overall measurement validation is achieved by using method triangulation to link micro and macro scale observations. The ethnographic study design allows for investigations of particularities in interaction without leaving aside the bi-directional link between particularities and an overall cultural and organisational trajectory at a macro level. Different methods are used to cover practitioners' cognition *in situ* and reflections on action by combining video-observation (investigation of what happens) with qualitative

[12] The software was designed by Paul Boersma and David Weenink, University of Amsterdam. For an introduction to Praat, see: praat.org April, 2nd, 2015.

interviews (what practitioners think happened). Thus, as the project aims at providing original empirical insights about *how* cognitive events are managed in situated particularities over empirical generalisability, qualitative analyses make up the main contribution in answering the research question.

The interactivity-based framework does not dictate a fixed order of analytical steps. Rather, the different perspectives offer a specific insight into the complexity of human interactivity with the use of specific approaches. Due to this project's research question, few analytical steps are defined to frame the analyses. First, based on coding, six themes for further investigations have been selected. Within these themes, single-cases are chosen for further analysis. Second, to show how cognitive results are achieved, the next step is to demarcate cognitive events. However, as a starting point, the analyses work from the enchronic timescale (Enfield, 2014) and define a nested cognitive task within the overall diagnostic process. By so doing, it identifies relevant event pivots, phase transitions and other intriguing moments in interaction in a way that opens up for questions about how cognitive results are achieved or how practitioners are inhibited in achieving results within cognitive systems. Third, to move beyond investigations of the enchronic timescale, both more rapid and slower timescales are integrated into investigations. As the enabling conditions of human cognition are tied to timescales beyond the conversational timescale, e.g. those that are tied bio-mechanics and sociocultural norms (Thibault, 2014: Steffensen, 2012; 2013; Cowley and Nash, 2013; Vallée-Tourangeau, 2013; Cowley and Vallée-Tourangeau, 2013; Jensen, 2014b), these scales beyond the conversational level need further attention. As mentioned in chapter 3 various analytical methods and theoretical perspectives can be integrated into analysis. Thus at a macro-level, theoretical concepts are applied to support interpretations of real-time actions. For instance, the analyses use concepts as 'voiced others', sense-making, values realisation, direct perception and affordances as heuristics to investigate aspects of human interactivity. The particular use of a theoretical perspective depends on the theme and cognitive complexity underlined within the given chapter.

To trace rapid dynamics of interactivity, CEA has developed a methodological analysis that goes beyond sequential temporal analysis and pivots on moments of changes in the interactivity flow. This project uses and expands CEA's specific presentation style to show the pico-scale dynamics that go beyond sociocultural timescales such as those annotated in verbal transcriptions of talk.

5. Medical visual systems in diagnostic processes

5.1 The hypothesis of visual perception in diagnostic processes

Achieving a diagnosis is the overarching shared goal at the emergency ward. How this is done depends on multiple factors such as the practitioners' abilities to relate symptoms to causes, interpret patients' narratives, and connect experience and knowledge to real-time occurrences. How these processes unfold is especially interesting when challenges emerge and creative strategies must replace the usual procedures. In the dataset, there is a striking difference in the way practitioners handle the diagnostic process when faced with challenges. Indeed, their actions do not indicate that their perceptions rely on objective representations. Rather, they tend to imply situated initiatives based on direct perception (Gibson, 1979/86; Noë, 2004). The chapter is based on the hypothesis that perception does not only depend "on the eyes in the head on a body supported by the ground" (Gibson, 1979/86:1) but just as much on sociocultural constraints, individual experience and local dynamics, which makes perception a result of a sense-saturated visual system. Furthermore, if perception is sense-saturated and depends on local and non-local coordination, different people use different strategies in order to achieve the same output. If this hypothesis is supported it has educational consequences for how practitioners are trained. The complexity that follows such a view leads to a deeper investigation of a practitioner's level of expertise in relation to environmental affordances for proper action. In the light of this, designing medical materials or focusing on an individual's knowledge level, only deals with part of the cognitive ecology of medical problem-solving.

Working from this hypothesis I investigate three cases from the dataset that all share

some core features and also represent different degrees of constraining elements in the process of diagnosing. Common to all three cases is the emergence of local constraints that force the practitioner to perceive and act on changes in the layout of affordances (Gibson, 1979/86; Chemero, 2000; 2003). The way the practitioners adapt to the changes is related to feedback mechanisms and error cycles. The cases differ with respect to types of constraints, the medical and clinical situation and the level of expertise amongst the healthcare staff.

Generally, the chapter investigates how medical practitioners make use of a visual system that goes beyond local and individual interaction. It shows how medical decision-making is determined by local dynamics, sociocultural patterns, and individual experience. It argues that explanations of human interactivity cannot be confined to only the social timescale, e.g. Enfield's enchronic timescale (Enfield, 2014). I exemplify this by investigating three cases from emergency medicine where problem finding and problem-solving are related specifically to vision. The focal point of the investigations is on how problem finding and problem-solving are constrained by a medical visual system. The function of a visual system is directly related to the conditions of error cycles, which will be demonstrated in the analyses and discussed in the conclusion of this chapter.

The first case shows (*a*) that the novice doctor prioritises a sociocultural timescale, that furnishes her with retrospective information, over the real-time timescale of local interaction, which *ceteris paribus* could have contributed with valuable knowledge; (*b*) that cultural artefacts in the medical arena, which are themselves material products of past sociocultural events, can both facilitate and obstruct conducive cognitive processes; and (*c*) that medical novices during their education have acquired deep, specialised knowledge of medical procedures and categorisation via medical textbooks and classes. However, in real-life medical encounters, such abstract knowledge may be at odds with the experiences and aspirations of the interlocutors, at the peril of a dialogical medical practice.

The second case shows how an experienced doctor and his medical team mould the optic array as he draws on interactivity. The sense-saturatedness allows for an immediate and intentional, but at the same time automatic locomotion that serves as a positive feedback mechanism in the interactivity trajectory. The team's anticipatory actions feed back on the latent conditions for errors in a functional way. Finally, the third case demonstrates an element of learning as a doctor seeks to perceive new possibilities by moving, probing and manipulating the problem space within the environment. Before I present the cases, I discuss how the ecological approach to visual perception is related to the hypothesis and the analytical methods used in the analyses.

5.2 Distributed visual systems: what makes human perception special

When doctors act in a medical environment, they depend on vision, i.e. what and how one sees, feels and perceives in action. With Gibson I reject the hypothesis that we perceive the environment with our eyes: "We are told that vision depends on the eye, which is connected to the brain. I shall suggest that natural vision depends on the eyes in the head

on a body supported by the ground, the brain being only the central organ of a complete visual system" (Gibson, 1979/86: 1). Seeing is a distributed activity that requires a whole visual system to work (Gibson, 1979/86; Noë, 2004). Gibson's approach has proven itself useful and it has intrigued many scholars by arguing against mental representation as the key to understanding visual perception. However, Gibson's objective was to show the automaticity of real-time action-perception-cycles of an organism-environment system (Järvilehto, 1998; 2009) constituted by both the embodied effectivities of the organism and the functional affordances of the environment (Gibson, 1979/86:36). Gibson did not seek to explain the historicity of perception, nor its symbolic or cultural aspects. Rather, he focused merely on the timescale of real-life perception:

> Human observers cannot perceive the erosion of a mountain, but they can detect the fall of a rock. They can notice the displacement of a chair in a room but not the shift of an electron in an atom. […] emphasis will be placed on events, cycles and changes at the terrestrial level of the physical world. The changes we shall study are those that occur in the environment. (Gibson, 1979/86: 12)

Gibson's approach to perception expanded the perceptual system in space but not in time. Gibson derives his explanatory power from what happens in an animal's physical encounter with the physical environment. Contrary to this local time view on perception, Goodwin (1994; 2002; 2003; 2007) scrutinises the sociological aspect of how the environment affords various perceptions amongst different groups of people. For instance, he links situated cognition of professionals to processes of classification that guide relevant action-perception cycles to achieve a successful outcome in real-time. In the following statement he exemplifies this line of thought by describing how archaeologists use coding schemes to provide equivalent observations in a way that literally transform nature into culture:

> by using such a system a worker views the world from the perspective it establishes. Of all the possible ways that the earth could be looked at, the perceptual work of students using this form is focused on determining the exact color of a minute sample of dirt. They engage in active cognitive work, but the parameters of that work have been established by the system that is organizing their perception. In so far as the coding scheme establishes an orientation toward the world, it constitutes a structure of intentionality whose proper locus is not the isolated, Cartesian mind, but a much larger organizational system. (Goodwin, 1994: 609)

When repetitive interaction sculptures categorical patterns and forms over time, they provide the interlocutors with a *professional vision* (Goodwin, 1994), an expert view that is often materialised into "objects of knowledge that become the insignia of a profession's craft: the theories, artefacts and bodies of expertise that are its special and distinctive domain of competence" (Goodwin, 1994: 606). In the following analysis, it is underlined how human perception stems from cultural knowledge and real-time flexible, adaptive behaviour. Relating Goodwin's term 'professional vision' to Gibson's 'visual system', I account for how perception is embedded in an extended space-time. In other words, a

distributed visual system defines the ecological array of enabling conditions for perception. Hence, what a doctor sees, feels and perceives is both socially pre-organised through material-cultural artefacts and the implementation of procedures and narratives, and it is dynamical, anticipative and situated.

5.3 Case 1: temporal dynamics and visual perception

5.3.1 The doubling of the patient: real patients and surrogate patients

The interlocutors in the first case are a novice, female doctor and an alcoholic, male patient. The patient's GP has sent him to the hospital, primarily because of his yellow eyes, which is an indication of a hepatic disease. He is lying in a bed facing the doctor who is seated right beside him. In her hands she holds the patient's medical record. See figure 5.1 for an overview of the layout.

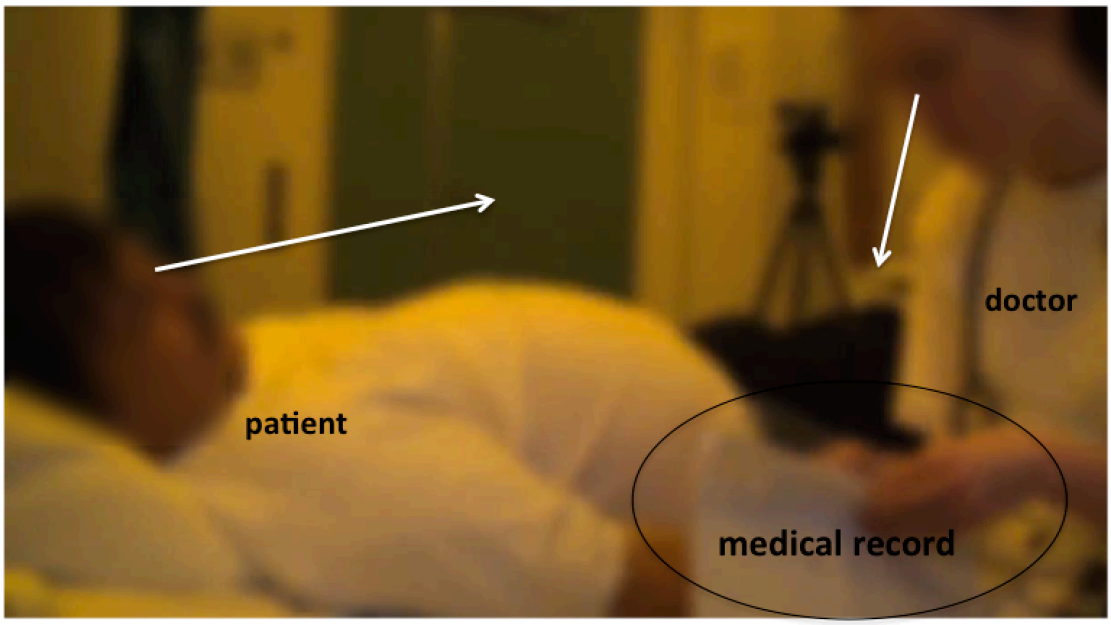


Figure 5.1: Overview of the layout: visual attention

As we enter the conversation, the doctor has just examined the patient, and next she asks the patient what colour his faeces have been over the last few days. This is important because it gives a further indication of the functionality and condition of the liver. In this case, I scrutinise how they relate to the topic of his faeces.

As stated, the doctor is holding the patient's medical record in her hands. In the record, she has information about the patient's history, partly from the GP, partly from previous encounters at the hospital. As she starts interrogating the patient on his faeces, a problem of clarification emerges, because the patient does not confirm what the medical record says:

Transcript 5.1[13]

DANISH ORIGINAL

1. D: dels så har du: fortalt at du har noget hvid afføring (.) o:g (0.1)
2. P: noget hvad
3. D: =NEJ (0.3) nu skal jeg lige se igen (.) noget SORT afføring (0.3)
4. P: nå:rh jamen han spurgte hvad farve det var og så siger jeg det er både den ene og den anden
5. D: jamen for det er både hvidt og sort >indimellem er det BLEG- eller blegt< ↑ik
6. ps: (1.0)
7. P: °°jo[h altså ø:h°°
8. D: [det er det
9. Ps (1.6)
10. P: jeg har som regel altid tynd mave men altså:
11. D: ↓mm
12. P: el lidt tynd mave ik (0.2) men øh
13. D: har du afføring hver dag
14. P: jah
15. ps: (1.6)
16. D: og de:t okay
17. ps: (0.5)
18. D: men ha- d ka det være °sån b bleg° nogen gange
19. ps: (0.5)
20. P: °nej blegt° altså hvad mener du (0.3)
21. D: jamen det de:t er nemlig os t (.) et tegn på at man kan være der kan være noget galt med leveren eller galde(.)bl[æren
22. P: [ja
23. ps: (0.5)
24. P: altså de[t er ik øhh der er ikke øh hvidt eller uden farve eller↓
25. D: [eller er det mig der husker forkert
26. D: ↓mm men det kan være sort nogen gange (0.3)
27. P: ja:eh så er det det mørkere mere eller mindre altså det ka så [normalt er det sådan mørkegult ik (.) eller jeg ved ik hva (0.2) [hva det er normalt at være
28. D: [↓mm [mm
29. D: MØRKEGULT (0.2)
30. P: altså sådan gulligt eller j[a
31. D: [ja okay
32. P: altså
33. ps: (0.6)
34. D: så det vil sige lidt blegere
35. ps: (0.8)
36. P: phh[h
37. D: [eller kitfarvet (.) sådan lerfarvet måske
38. ps: (1.0)
39. P: °°nja°° (.) [hvis det sku-
40. D: [?fedtet
41. ps: (1.0)
42. P: det tror jeg ik (0.2)
43. D: nej okay (.) det er ps de:t er øh lidt (.) underligt din læge har skrevet det her det må jeg ærligt indrømme det (xxx) aldrig hørt [før

[13] When the text is marked in grey, it indicates that the doctor gazes in the clinical record. Otherwise, she looks at the patient.

ENGLISH TRANSLATION

1. D: and then you: have told that you have some white faeces (.) a:nd (0.1)
2. P: some what
3. D: =NO (0.3) let me see again (.) some BLACK faeces (0.3)
4. P: oh yes but that is he asked what colour it was and then I say it is both the one and the other
5. D: well because it is both white and black >sometimes it is PALE- or pale< ↑right
6. Ps: (1.0)
7. P: °°we[ll that i:s°°
8. D: [that is
9. Ps (1.6)
10. P: usually I have diarrhoea but ehm:
11. D: ↓mm
12. P: or a bit diarrhoea right (0.2) but ehm
13. D: do you have faeces every day
14. P: yes
15. ps: (1.6)
16. D: and tha:t okay
17. ps: (0.5)
18. D: but ha- d can it be °kind of p pale° sometimes
19. ps: (0.5)
20. P: °no pale° well what do you mean (0.3)
21. D: well it i:t is actually also s (.) a sign of that one can have that something can be wrong with the liver and the gall(.)blad[der
22. P: [yes
23. ps: (0.5)
24. P: well i[t is not ehh it is not eh white or without colour or↓
25. D: [or do I remember it wrong
26. D: ↓mm but it can be black sometimes (0.3)
27. P: we:ll then it is a bit darker more or less well it can then [normally it is kind of dark yellow right (.) or I do not know [what (0.2) what is normal
28. D: [↓mm [mm
29. D: DARK YELLOW (0.2)
30. P: well kind of yellowish or y[es
31. D: [yes okay
32. P: well
33. ps: (0.6)
34. D: so that is a bit paler
35. Ps: (0.8)
36. P: phh[h
37. D: [or kit coloured (.) kind of clay coloured maybe
38. Ps: (1.0)
39. P: °°no°° (.) [if it shou-
40. D: [?sticky
41. ps: (1.0)
42. P: I don't think so (0.2)
43. D: no okay (.) that is ps tha:t is eh a little (.) strange your doctor has written this I must admit that (xxx) [never heard of [before

In line 1, the doctor starts to summarise what she presumes the patient has told his GP. At the same time she creates an interaction with three interlocutors: herself, the biological patient and a surrogate patient. Clark (2008) introduces the term *surrogate situations* to explain how real-world structures often are used to stand in for a potential or possible real event that serves as the decisive object of a certain cognitive undertaking (Clark, 2008:152-154). Inspired by this creative coupling, I use the term *surrogate patient* to indicate how the doctor uses real-world structures as stand in for the real biological patient. The surrogate

patient represents the present biological patient in the format of numbers and words in the medical record. The creation of the surrogate patient is indicated in the linguistic construction of a second utterance as well as by the doctor's physical orientation within the distributed cognitive system. See figure 5.2 below. In line 1, the doctor utters *you have told* as she gazes directly at the patient. Right after she introduces the surrogate patient by saying that *you have some white faeces* as she simultaneously gazes in the record. The two deictics, in line 1, refer to two parties: the real patient and the surrogate patient, respectively. The doctor subsequently orients to the real patient to see how he reacts. When the patient objects in line 2, *some what,* the doctor re-orients towards the narrative in the record *=NO let me see again* (line 3).

	D gazes at P	**D gazes at the record**	**Comments**
1. D:	and then you: have to (.) a:nd (0,1)	ld that you have some white faeces	'you' is a second person deictic that refers to the real patient 'you' is a second person deictic that refers to the surrogate patient, mediated by the record Looking at P, the hesitation prompts the real patient to produce a turn (in line 2)
3. D:	=N	O (0,3) let me see again (.) some BLACK faeces (0,3)	D re-orientates from the real patient to the surrogate patient; the information is attributed to the surrogate patient's narrative to the GP
5. P:	PALE- or pale< ↑right	well because it is both white and black >sometimes it is	D's logical connector, 'because', recapitulates the medical record, not the real patient's narrative to her in the situation. '↑right' functions as a discourse marker that prompts the real patient to confirm her utterance

Figure 5.2: The real patient versus the surrogate patient

In line 4, the patient recalls the conversation with his GP *oh yes […] he asked what colour it was and then I say it is both the one and the other.* This answer leads to a paradox, since it is very unlikely that the patient's faeces have two colours simultaneously. Thus, the answer indicates several possibilities: (*a*) it could be the case that the patient merges several answers into one (if his faeces were different colours at different times) (*b*) he feels uncomfortable when taking the whole situation into consideration (the topic, his situation etc.) and thus just comes up with something to please the doctor; or (*c*) he constructs a narrative that fits the proposals of the doctor: *the one and the other* (line 4) corresponds to her *white faeces … BLACK faeces* (line 1-3). The doctor reacts by adding another category in line 5: *>sometimes it is PALE- or pale< ↑right*. In doing so, she seeks to bridge the gap between the surrogate patient and the real patient, but the patient is unable to produce a meaningful response, which indicates that he is confused by her attempt to make him confirm the surrogate patient's narrative in the medical record.

In medical surrogate situations, there is often a need to compensate for human absence, for instance when heart rate and basic rhythm are represented in electrocardiograms. In this encounter, however, the patient is present and able to co-act with the doctor, but the doctor fails to see him as a cognitive resource. Instead of engaging with the patient, she produces the answers herself and seeks confirmation afterwards – to the great bewilderment of the patient.

In an emergency ward, the medical problem is often unknown and the relevant diagnostic variables are not given in advance. Under such conditions, practitioners are forced to engage in, not merely problem-solving, but crucially in problem *finding*. In problem-solving activities, the problem is known and the doctor is the problem solver and hence the main cogniser within the distributed cognitive system. In problem finding, the diagnostic process is a non-linear mixture of procedural thinking, abductive hypothesis-testing, and solution probing (Steffensen, 2013). The medical practitioner needs to rely on coaction between patient and doctor to generate valid hypotheses. This means that both cognisers are equally important, and successful diagnosing requires a focus on both medical measurements as well as engagement with the patient in a sensitive and dialogical way. The medical visual system is a result of how the novice doctor, in this case, takes refuge in the medical record where she looks for clues as to what the exact problem is. Thereby she reduces the problem finding process to one of problem-solving, and the situated cognitive dynamics do not match the patient's situation. In the words of the ecological time model (cf. chapter 3.3), she has not developed sufficient professional experience on her autobiographical timescale, and she thus takes recourse in the institutional logic of using external authorities, here the patient's GP, as a resource for problem-solving.

5.3.2 The heterarchical roles of artefacts

In this section I investigate the function of sociocultural artefacts in the encounter between the novice doctor and the patient. In doing so, I plan to show that past events, materialised as artefacts and tools, can affect the here-and-now interaction, mediated by medical tools. Many tools increase the power and precision of human agency, just as they extend the peri-personal action space (cf. Kirsh, 2013) in a way that is needed in order to complete a specific goal: a hammer is needed to hit a nail, and a racket is needed to hit a tennis ball. Many tools and artefacts in the medical ward facilitate communicative and cognitive actions, not by extending the action space, but by structuring it. Thus, where some tools by default secure a better outcome than if the tools were not used (for instance in tennis) many other tools have a facultative character in problem-solving and task performance. They may facilitate cognitive tasks and aid to maintain an overview in complex situations, but they can also have adhesive effects. An expert has learnt when tools constrain the action space, and when he is better off by not using the tool to perceive what to do. Maps are less used by experienced way finders, guidelines are less explicit in the world of experts, and training wheels are not needed when the rider becomes confident and brinkmanship reaches a certain level of expertise. The expert doctor thus knows when to rely on tools,

and when not to.

This insight is important and gives rise to a new understanding of perception, not as passive representation, but as a result of interaction within the environment over time. While tool-enabled actions allow for new affordances to emerge, they also narrow down the affordances of the non-tool agent system. As stated by Kirsh (2013) these new behavioural forms are not natural and innate, they are cultural and hence only natural in the artificial world that we inhabit today (Kirsh, 2013: 3:9). Thus, we need to learn to handle tools, and occasionally also to learn to abstain from handling tools. A visual system is continuously shaped and advanced through interactivity encompassing the environment, history, norms etc. In many professions, this interactivity is pre-organised in educational systems that in themselves function as surrogate situations where novice practitioners learn, not by doing, but by anticipating. Because the inherent intentions built into textbooks, guidelines, and other medical artefacts by necessity are abstracted from reality, a crucial part of developing expertise is the ability to judge when such intentions do not fit real-life medical situations.

In the following, I turn the attention to how one such material artefact, the medical record, both constrains and facilitates problem-solving. As shown above, the doctor constantly holds on to the record during the conversation. The artefact serves as a cognitive resource: it enables the doctor to link information elicited by other practitioners to her own observations so she can generate hypotheses. However, the way she handles it also affects the interpersonal relation between the doctor and the patient negatively.

In the transcript above, the patient objects to the doctor's statement in line 2, *some <u>what</u>.* The doctor is thus forced to re-evaluate her utterance and come up with a new result. In line 3, she utters *=NO (0.3) let me see again (.) some <u>BLACK</u> faeces (0.3)*. From the verbal utterances alone, it seems as if the doctor looks in the medical record and spots the right answer, which enables her to generate a new category *<u>BLACK</u> faeces*. Nevertheless, a detailed analysis of this episode unveils another explanation. As the doctor utters *=NO (0.3) let me see again (.)*, she puts the medical record in front of her. At first glance, it looks as if the doctor searches for the right answer in the record, where she can *see* it. However, even before she has opened the medical record, she has started to produce the new answer, see figure 5.3.

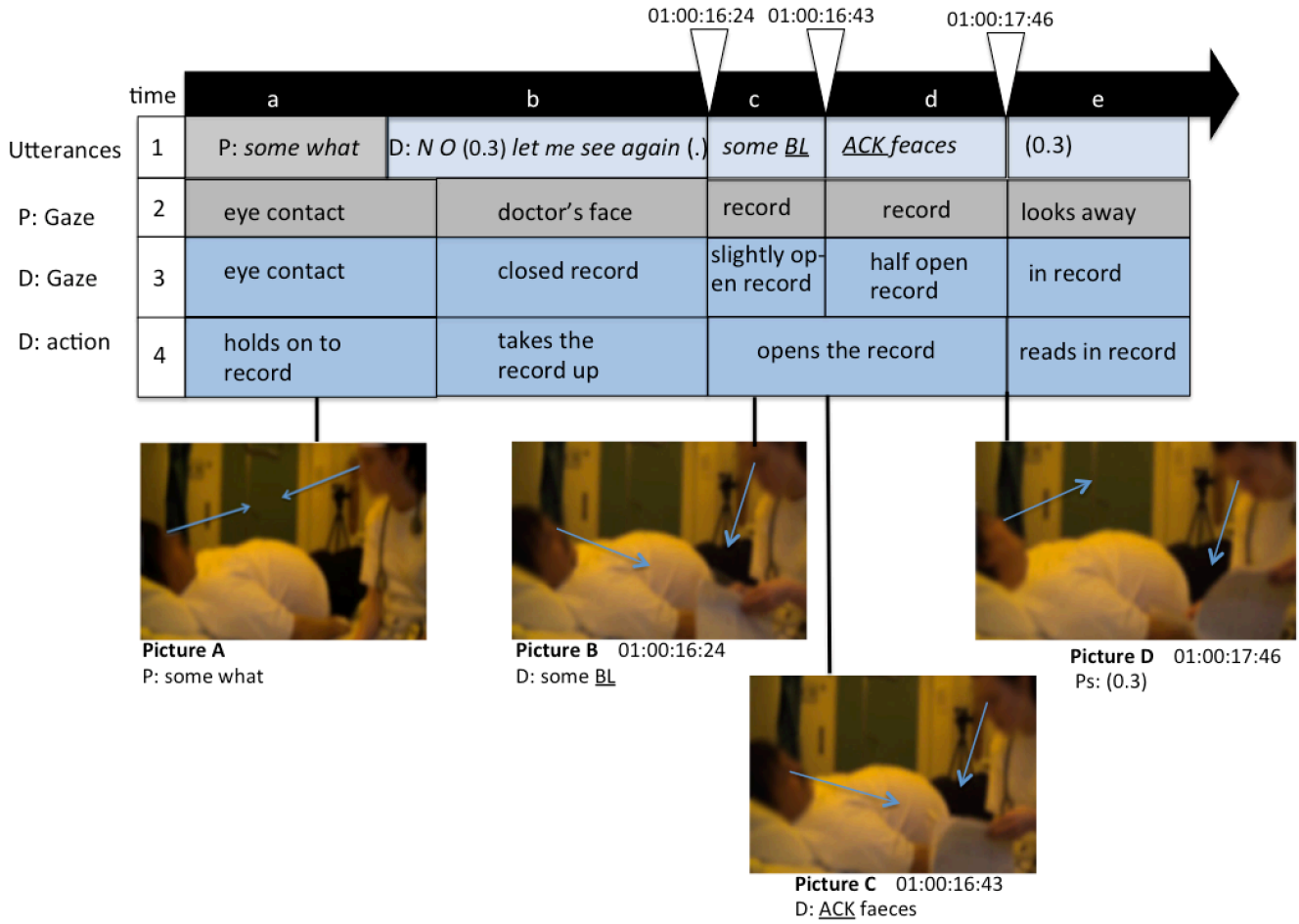


Figure 5.3: Gaze patterns and the opening of the medical record[14]

In picture A the doctor and the patient have eye contact. However, as the patient does not confirm the doctor's utterance, the doctor immediately assures the patient that she will have a second look (see figure 5.3, box 2a and 2b). Hence in picture B, the doctor has already produced an alternative answer and the record has hardly been opened. Thus, she does not *see* the answer in the record. As the doctor utters *NO (0.3) let me see again (.)* the patient continues to gaze at the doctor, even though the doctor now orients to the record (see figure 5.3, box 4b). The interaction has now changed from coaction to individual action, since the doctor interacts with the surrogate patient rather than the real patient. In the pictures, the gaze pattern is indicated. As the eye contact in picture A is broken, the patient too gazes at the medical record, which has become the locus of interest (see picture B). In picture D, he gazes at the wall and the distributed cognitive system disintegrates. The doctor uses the artefact in a way that excludes the patient both cognitively and interpersonally. Because the patient has the answer, but is being excluded from the cognitive process, the problem finding activity is more complicated and time consuming

[14] Since I have no access to these data anymore, I cannot get hold of the exact time-code of picture A. If necessary, see figure 5.3.

than necessary.

From an interpersonal or dialogical perspective, the way the doctor handles the record affects the interactivity negatively. The doctor's visual system serves as a display for the patient and the way she handles the material artefact creates a boundary between the two. The boundary is both cognitive (the thinking becomes more individual and draws on personal experience rather than on coaction) and physical (the way the doctor holds the medical record makes it a physical barrier between the two and it guides her visual attention from the real patient to the surrogate patient). The artefact serves as a constituent in several ways. It facilitates cognition and it affects interpersonal relations since it has a boundary constitutive effect. The doctor uses it to hold on to, to search for information in and to demarcate a distributed cognitive system for hypothesis generating. In this case, however, the artefact constrains the doctor's visual system. She is so keen on solving the problem that she neither sees nor feels the inter-bodily dynamics in real-time. It harms the dialogical relation with the patient, because he – a major cognitive resource – is being excluded.

The distributed cognitive system is dysfunctional since it only builds on the institutional timescales incarnated in the artefacts; it completely omits the autobiographical memory of the patient. The novice doctor relies on the symbolic properties of the record, and in so doing she ignores the fact that the record has concrete material properties too.

In this analysis, I have shown how the material artefact – more than the symbolic representation incarnated in it - serves as an element in the distributed cognitive system by narrowing down the peri-personal sphere: it constrains the visual system of the doctor due to its ability to force gaze, attention and sensitivity in a certain direction.

5.3.3 Semantic memory: categories as constraints in diagnostic processes

The final analysis of this example scrutinises how abstract information structures (Baber et al., 2006) guide practitioners' perceptual processes via symbolic and semantic values established by a large and situation-transcendent, educational system. Thus, the doctor's education provides her with an intentionality that goes beyond what happens in local interaction. On a slow sociocultural timescale, the novice doctor's educational background has equipped her with perceptual categories that guide her real-life perception. Within the educational system, practitioners are educated to solve problems (diagnose) on the basis of a given set of variables. The educational system thus provides practitioners with expertise by narrowing down what they pay attention to. When successful, this equips the novice with a pseudo-experience (i.e. she can rely on other persons' experiences, as if they were her own); but at times novices face unexpected and irrational circumstances, and in such situations the educational visual system can almost blindfold them and limit their sensitivity to the real-time dynamics – at their own and their patients' peril. In other words, in can lead to human errors.

In this case, I will show how the novice doctor's vast categorical knowledge functions as a constraint as well as a necessity in diagnosing. Throughout the interaction, the doctor

seeks to determine the colour and the consistency of the patient's faeces. However, there is no sign of any clarification. On the contrary, while the doctor produces a cascade of colour categories, all of them being more or less fixed categories that stem from the educational system, the patient responds by producing fewer and vaguer categories, see figure 5.4.

FAECES CATEGORIES WITHIN THE SEQUENCE			
Line	**Doctor's fixed categories**	**Line**	**Patient's vague categories**
l.1	white	l.4	the one and the other
l.3	BLACK	l.20	no pale what do you mean
l.5	both white and black	l.24	not white or without colour
l.5	PALE- or pale	l.27	that darker more or less
l.18	°kind of p pale°	l.27	dark yellow
l.26	black	l.30	kind of yellowish or
l.34	a bit paler		
l.37	kit coloured		
l.37	clay coloured		
l.40	?sticky		
l.29	DARK YELLOW (patient's category)		

Figure 5.4: Semantic categories

If one compares how these categories relate to well-known colour classifications, as the colour spectrum in figure 5.5 below, the lack of conversational clarification is apparent from the categorical distance from the doctor's categories to the patient's. The two interlocutors simply seem to navigate semantically in different parts of the colour spectrum.

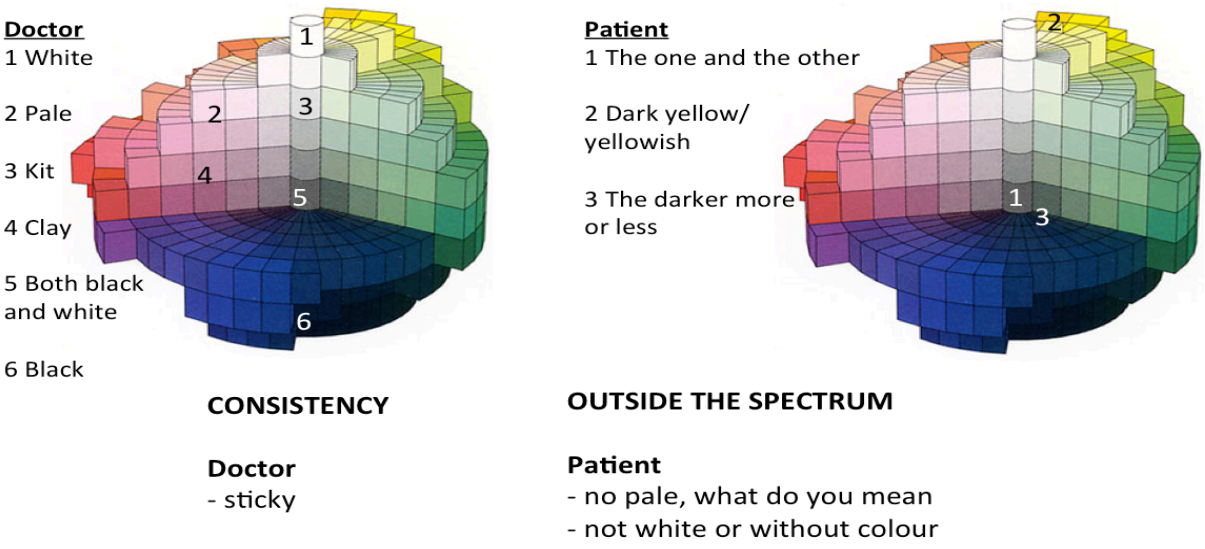


Figure 5.5: Colour spectrum

As the conversation proceeds, the doctor becomes increasingly frustrated. Her frustration is recognised, above all, in the cascade of categories fired at the patient. But her facial expressions also reveal a growing level of frustration, as illustrated below in figure 5.6.

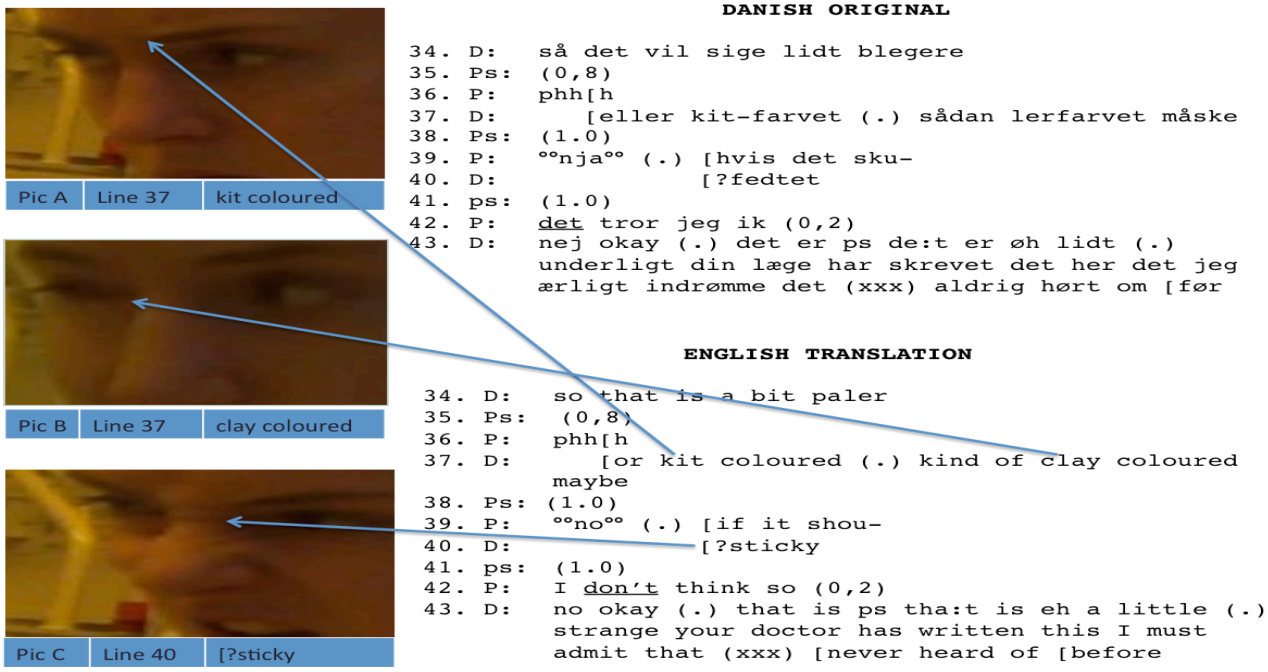


Figure 5.6: The doctor's category firings and facial expressions

Her "category firings" at the end of this diagnostic task, shows as a final attempt to match her categories, derived from the educational system, with the ones of the patient. The doctor is fixated on verbal descriptions that almost sound like rote learning of colour names. However, by taking a closer look at the doctor's facial expressions as she proposes these categories, it becomes evident that she herself doubts their relevance. In figure 5.6, picture A, the doctor furrows her eyebrows when she utters *kit coloured.* In picture B she blinks with her right eye when proposing *clay coloured.* And finally, in picture C, she wrinkles her nose when uttering: *sticky.* The doctor's facial expressions, and particularly their fine-grained synchrony with the semantic categories, are noteworthy since they mark a change in the flow of the interactivity: she produces a series of categories while facially marking them as non-conducive to reach her goal of categorical clarification.

Unsurprisingly, the result is frustration on her part and confusion on the part of the patient. The latter shows in the still longer pauses in his turns: 0.8 seconds in line 35, 1.0 seconds in line 38 and 1.0 seconds again in line 41 and in his hesitating and desultory utterances: *phhh* (line 36), *°°no°° (.) if it shou-* (line 39) and *I don't think so* (line 42).

Being constrained by the sociocultural resources of medical school, the doctor fails to integrate her categorical knowledge with what happens in real-time. Her educational system is grounded in a "word-world" (Pedersen, 2010; 2012), and she thus relies on a diagnostic hierarchy with verbal categories in the top. Guided by this hierarchy she

searches for the linguistically expressed "truth" about the patient's faeces. The semantic categories from textbooks and the contradictory narratives of the real and the surrogate patient confuse the doctor and prompt her to be insensitive to how the patient feels and what he expresses in situ. As shown, her strategy biases effective and dialogical diagnosing. The bottom line is that the doctor fails to establish a distributed cognitive system and engage with the patient as a living being who is able to recall experience and provide reports of his experiences. The doctor sticks with a naïve view of what vision offers (e.g. memories of what colour names name), and it is striking how little use the doctor makes of the resources available. She almost exclusively focuses on abstract information structures. Thus we witness a doctor who is blocked by cognitive economics, because her focus on colour names happens at the expense of her ability to feel the inter-bodily dynamics in real-time.

The doctor fails to initiate ways of seeing that might prompt her to deal with the situation in a more conducive way. She engages in dysfunctional cognitive work, which is biased by parameters established by other professionals. And as such her intention, attention and cognitive dynamics are not just guided and framed, but rather fixated by a larger system than her as an individual (cf. Goodwin, 1994), in this case the educational system.

From a design perspective, much can be improved to enable the patient to be able to recall, identify and confirm shape, appearance and texture of his or her faeces. All the constraints we observe in the above examples may be facilitated through visualisation as done by the Bristol stool form scale, see figure 5.7 below.

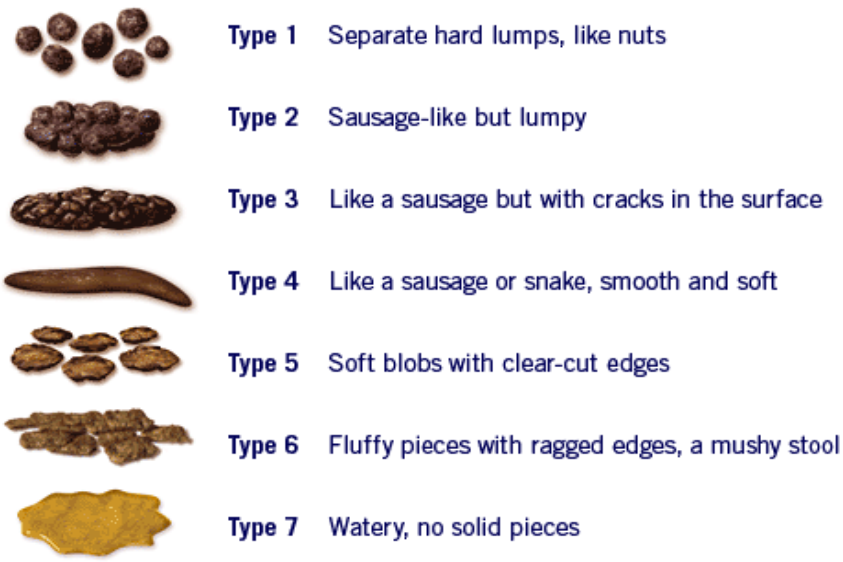


Figure 5.7: The Bristol Stool Form Scale[15]

[15] Lewis and Heaton (1997).

Such a material artefact might scaffold memory and facilitate situated cognition. The chart scaffolds memory as it uses both symbolic and visual surrogate systems that trigger memory differently. The implementation of such tools in practice will enhance the dialogicality since it requires active cognitive work from the patient and the tool serves as a shared object, which all parties orient to and it will reduce the level of errors in information elicitation. Finally, it would be less time and energy consuming and would ease the interpersonal relations since the responsibility of the cognitive work would be distributed between the participants.

Overall, the analyses emphasised how multiple organising principles simultaneously constrain human interaction. I showed how a novice doctor's visual system both depends on local coaction and on non-local events (cf. Steffensen and Cowley, 2010), such as the patient's prior visit to his GP, the doctor's experiences from medical school, and the sociocultural practice embedded and incarnated in the medical record as a tool and artefact. These non-local constraints became observable in how the doctor oriented to both the real-time patient and the surrogate patient in order to manage multiple, causal frames simultaneously. They also showed in her fixation on categories, rules, and procedures at the expense of situational awareness. Also, I identified the ambiguity and complexity of a distributed visual system encompassing historically given abstract information and artefacts. For instance, a medical record is not just a paper with representational information that needs to be decoded; both its materiality and the trans-situational intentions built into its design affect its situated functionality. In a similar vein, Benne argues that literary materials are sociocultural material artefacts with a supra-individual and ecological ontology and function:

> Die Ontologie der Literatur ist nicht nur kulturabhängig, sondern überindividuell und distribuiert. Dies gilt im Unterschied zur Affordanz im Tierreich für alle kulturellen Affordanzen. Die Materialität der Literatur ist deshalb nie allein von einer ontologischen Analyse der Materie der Literatur als ihrer reinen Stofflichkeit herzuleiten, sondern muss bereits die Rolle dieser Stofflichkeit in ihrer kulturellen Signifikanz und Affordanz umfassen, die sich im Erlebnis manifestieren. (Benne, 2015:116)

As literary manuscripts, the function and intention of the medical record, must be understood in relation to the intentions of design, the sociocultural and physical practice in which it is embedded and the situational circumstances in which it is being used. In this case, the medical record draws attention away from the patient and it frames perception and understanding due to its inherent intentions, symbolic content and pre-designed purposes that are worked out by a situation-transcendent system that goes beyond the real-time dialogical system. Sometimes such framing is needed; at other times it fixates and blocks perception and understanding of important expressions in the local environment. As a consequence such expressions are neutralised, or they might even become stress factors for the novice.

It is indeed a balance to know when the exclusion of aiding tools leads to more dialogical behaviour and a richer affordance environment, and when such tools give rise to

stress, cognitive overload, and interpersonal frustration. In this case the doctor is stressed because she prioritises the educational system, her fixation bias becomes a positive feedback mechanism in the cognitive system that leads to a dysfunctional outcome: no shared sense-making, thus no precise categorisation. This activity trajectory includes an potential error cycle that can lead bad outcome if dialogue is not prioritised. Further, the materiality of artefacts always affects inter-bodily dynamics by their mere material properties. In this case the medical record becomes the locus of interest rather than the patient right next to the doctor. That artefacts can affect local sensitivity is a concern that needs to be understood when tools are embedded in the field of emergency medicine.

5.4 Case II: sense-saturated visual systems, intentionality and tendencies in visual perception

5.4.1 Moulding the optic array through sense-saturated locomotion

In the following case, a medical team moulds and recalibrates its optic array through joint inter-bodily coordination. It is not a case of direct manipulation of an external object, but rather an interaction within the environment where the system itself is being manipulated. With CEA (Steffensen, 2013; Steffensen et al., forth.), the perspectives of dialogism (Linell, 2009) and ecological psychology (Gibson, 1979/86), I show how the team's movements constitute a shared intentionality that implies the maintenance of an optimal visual system that allows the team to keep focused on professional medical problem-solving without compromising the ability to keep track of what happens in the patient sphere. The following case involves a medical team that consists of a doctor, a nurse, a paramedic and a gastrointestinal surgeon from another ward. The surgeon brings with him a medical student that observes from a distance. The following is a visualisation of the setting and an indication of the multiple elements within the cognitive system.

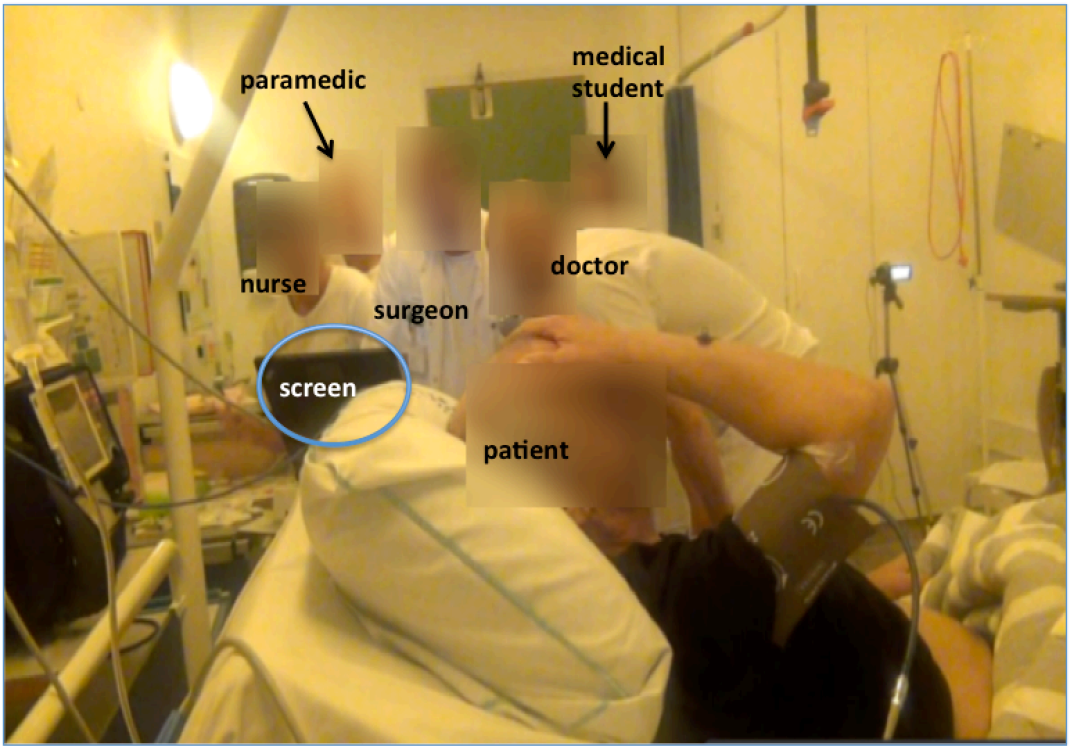


Figure 5.8: The layout and practitioner configurations in the cognitive system

The patient lies in bed and is obviously in pain. All practitioners stand around a computer screen. The two doctors explicitly evaluate the results of various tests that recently appeared on the screen. They provide various hypotheses in order to come up with a coherent diagnosis and strategy for further treatment. The nurse is occupied with medical measurements, reporting and general procedure following. The paramedic and the medical student observe from a distance and are loosely affiliated to the cognitive system that is organised around the two doctors and the computer screen. Figure 5.8 shows to what extent diagnosing is concerned with dealing with the surrogate patient. The medical team focuses on symbolic representations of the patient's medical condition on the screen as the real patient lies in bed, disconnected from the cognitive system next to him. This organisation is unavoidable since valuable test results, previous medical documented information etc. appear on the screen. However, the organisation is at the same time potentially critical for leaving the real patient alone at essential times during diagnosing. Indeed, successful diagnosing is concerned with how sensitively a team is able to balance artefact-scaffolded medical reasoning and patient interaction – and of course patient-artefact interaction. Such a balance requires that the team is able to focus on multiple things simultaneously in the diagnostic activity. This is exactly what the following investigates.

The computer screen in the centre is the immediate focal point and the real patient is irrelevant for the particular ongoing cognitive task of medical discussion. However, even though the real patient is not the immediate focus of interest, he is not treated as non-present and irrelevant in the overall picture as we will understand in the following.

The team is coordinated due to a shared project (Linell, 2009). However, while the doctors

are the main cognisers in this diagnostic event, they constitute a relatively autonomous system. Within the team there are different dynamics that are characterised by more or less autonomous connections. For instance, the nurse is cognitively more loosely associated with the team than the two doctors. The nurse is primarily occupied with the completion of individual procedures. In this excerpt the nurse is about to complete an individual task and she walks towards the patient. This action initiates a row of interconnected actions within the medical team that reorganises its position as a reaction to the changes in the layout of affordances, see figure 5.9 below and the gallery A-L further below.

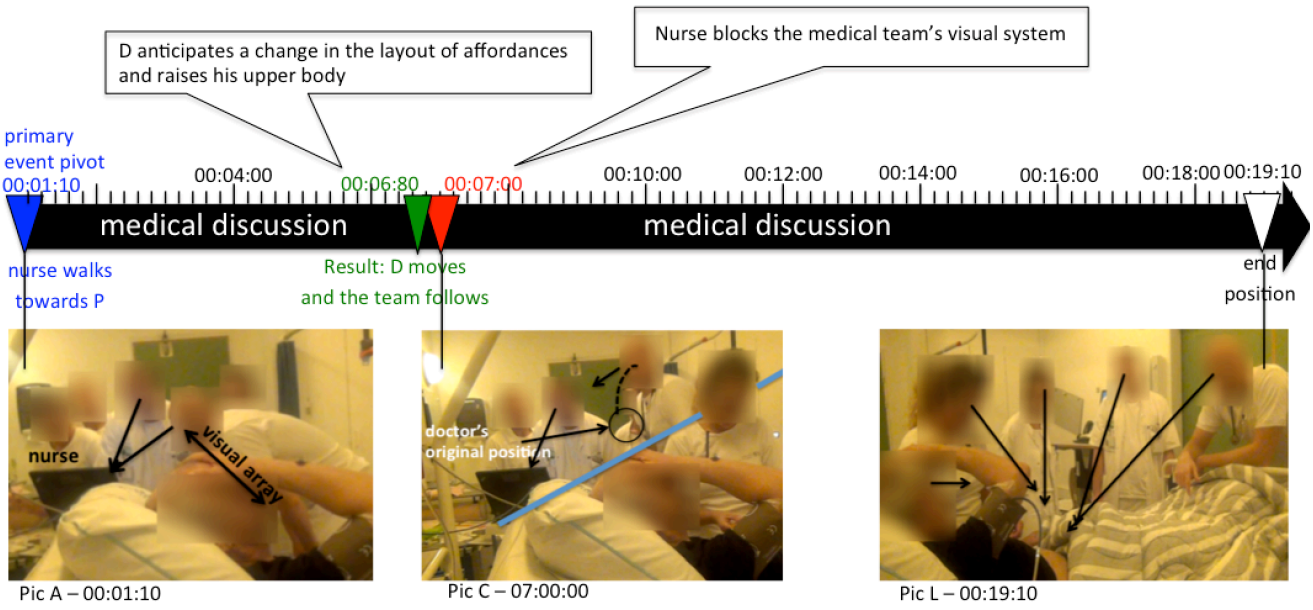
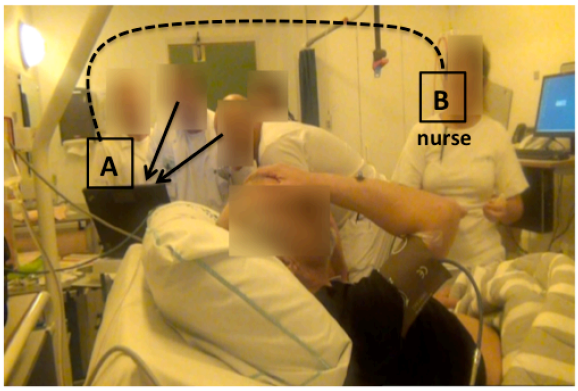


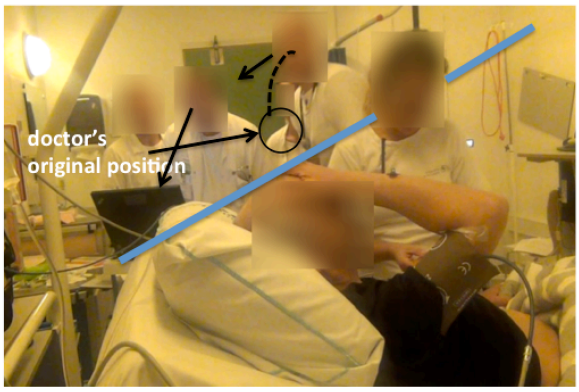
Figure 5.9: System reorganisation and cognitive focus
The blue line in picture C visualises the doctor's blocked visual access to the patient

Figure 5.9 shows how the nurse's movement prompts the team to move and recalibrate its boundaries without losing the cognitive overview: the medical team continues the medical discussion and hypothesis generating, and the doctor's movement is only functionally related to the movement of the nurse. Methodologically, the results are identified in the shift in the interactivity pattern: the doctor perceives a change in the dynamical relation and anticipates the consequences such changes in the layout of affordances entail. Because the nurse blocks the visual array between doctors and patient, the doctors are prompted to change position. Thus, the primary doctor initiates a move as a reaction to the change in the environment and to the potential future changes (Gibson, 1979/86). The nurse's movement is defined as the primary event pivot in the figure, as this action initiates a dynamical physical change in the team constellation. The anticipatory action is shown in figure 5.9 as the doctor moves before the nurse blocks the team's visual system. During this nested activity, the cognitive focus remains the same (see figure 5.9). In the following detailed gallery the overall flow of coordination is visualised. It shows the gaze, movement pattern and the visual array within the medical visual system.

Pic A – 00:01:10

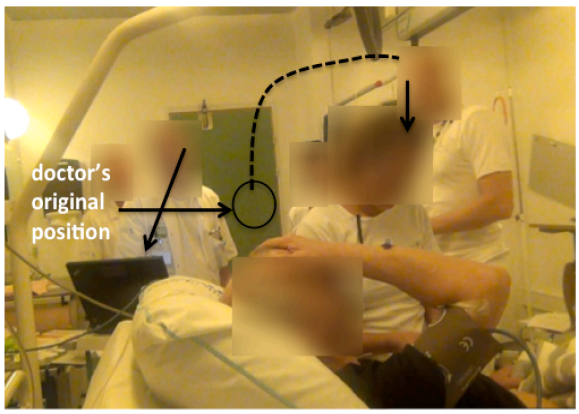


Pic B – 00:05:20

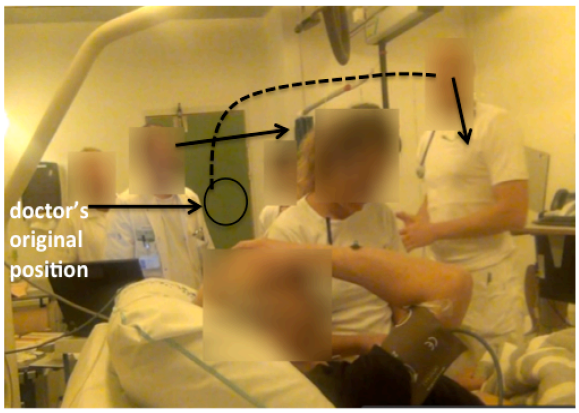


Pic C – 00: 07:00

Pic D – 00: 08:10

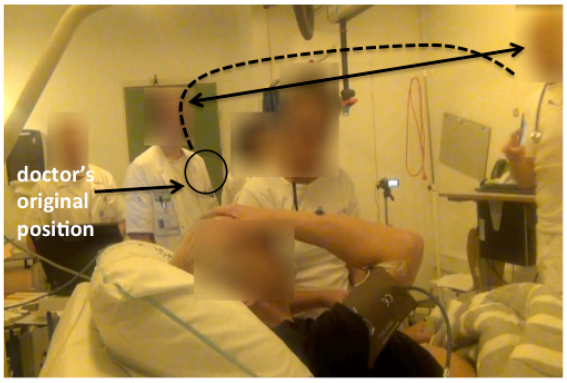


Pic E – 00:10:00



Pic F – 00:10:10

Pic G – 00:10:20



Pic H – 00:11:10

Pic I – 00:13:10

Pic J – 00:14:20

Pic K – 00:16:20

Pic L – 00:19:10

The medical team discusses specific medical issues that are completely unrelated to the movement pattern indicated in the gallery above. The doctor summarises the medical history and as the nurse moves around the medical team he utters: *well you just felt hi his pressure when he: arrived eh (xxx) eh when the ambulance arrives (xxx) it is 85 over 50 right.* The surgeon confirms and as the doctor has reached the headboard he continues: *and*

there has not been any (xxx).[16] Again the surgeon confirms the doctor's utterance and as they have both re-located to the end of he bed, (see picture K), they continue to evaluate the patient's medical situation.

In picture A+B the nurse walks from the corner, around the team and towards the patient. As she needs to place herself next to the patient to complete her tasks, she also blocks the visual array of the medical team (see picture C and D). The medical team focuses its attention on the surrogate patient. However, the team members need to be able to react to the slightest change in the real patient's condition. As his medical condition is critical, the focus of interest will change with any changes in his medical condition. Thus, because the nurse functions as a barrier of perception, the team is prompted to re-organise its position if the goal is to maintain a successful overview. In picture A+B, the team has full visual access to the patient's body. As the nurse gets in the way and blocks the team's visual access to the patient, the doctor has already anticipated this visual constraint and he raises his upper body and moves backwards away from the screen, even before the nurse is in the way (see picture C). At no time during this movement does the team stop the verbal evaluation of the patient's situation and the doctors continue to gaze at the computer screen as the doctor moves backwards (see picture A-D). The surgeon shifts his visual attention from the screen to the doctor as the physical distance between them increases and the doctor orients to the bed headboard (see picture E). 0.2 seconds later (00:10:20), the doctor reaches out for the headboard (see picture G). The two doctors gain eye contact (see picture H) and the doctor then holds on to the headboard and marks an end point of his movements (see picture I). As he holds on to the headboard the surgeon and the medical student join the doctor. The surgeon and the medical student walk towards the doctor who has now stopped and is leaning over the headboard (see picture J). The surgeon finds his place and now gazes towards the patient (see picture K). Finally, the whole medical team is at its new position and all team members have regained perfect visual access to the patient without interrupting their medical hypothesis generating activity (see picture L). Even though they perform individual cognitive tasks, they remain coordinated as a team and they constitute one cognitive system.

Jointly, they constitute a visual system and the re-organisation (from around the computer – to the end of the bed) affects the quality of the visual system positively. They anticipate possible changes in layout of affordances in a way that enables the team to adapt immediately to such changes. *If* the patient's medical condition changes, they will be able to pay attention to this immediately and they will furthermore be able to respond to it with a minimum of resources. The movements are nested within a cognitive problem-solving trajectory and we observe how a doctor through inter-bodily dynamics affects the locomotion of the whole team. This example does not describe a problem or an error, but

[16] DANISH ORIGINAL:
D: altså man mærker bare ha hans tryk da ha:n kommer øh (xxx) øh da [ambulancen kommer øh (xxx) det er 85 over 50 ik
(…)
D: og der har ikke været noget (xxx)

an anticipation that can be described as negative feedback mechanisms that prevent a potential problem from emerging. The feedback mechanisms unveil a case of sense-saturated locomotion probing rather than explicit goal-orientation (Steffensen, 2013; Cowley, 2014b). Qua the doctor's formal role as a primary doctor, he has a different responsibility for the patient than the surgeon has. The gastrointestinal surgeon's professional relationship to the patient is primarily characterised by a bio-medical focus on a specific body part. These different roles entail different foci within the medical team. The surgeon does not primarily orient to the patient as such and institutionally he is not the main responsible for the identification of the change in the environment as a relevant affordance for action. This is the job of the doctor. On the other hand the surgeon needs to and does also anticipate the movements of the doctor. The example points to how the same physical environment provides both shared and distinct affordances for actions for a medical team. The doctor perceives the nurse's movements as an affordance for re-locating the team's position, and the surgeon perceives the doctor's movements as an affordance for moving as well in order to maintain optimal conditions for problem-solving.

With interactivity it is possible to investigate how the non-local shows in the local, how inter-bodily dynamics mesh with social orderliness, and how perception is shaped by materiality and historical experiences as prerequisites for seeing useful action patterns and enacting intentions. The sense-saturated activity is identified in the pico-scale analysis that unveils that the team's orientation happens beyond explicit reflection. The movements are initiated in the mesh of inter-bodily dynamics too fast to be social. The non-local coordination that saturates the doctor's body with sense and his engagement with the team enables the other participants to coordinate with the doctor *in situ*. Nothing in the data indicates that there exists a local plan or calculations as such that afford the doctor to think of how the visual system works most effectively. He does not even *look* in the direction of the nurse or the headboard as he initiates the movements backwards (see picture C+D); rather, he *perceives* the reorganisation of the nurse as an important change in the layout of affordances that prompts him to move. The whole act, however, makes perfect sense, since the re-orientation results in an optimally distributed cognitive system where the team's visual array works to the best effect.

The ease with which the doctor anticipates the potential problem can be explained by the power of interactivity, which transcends local timescales (Steffensen, 2013; 2015; Pedersen and Steffensen, 2014; Steffensen and Pedersen, 2014). His repeated structural coupling with a relatively stabile distributed cognitive system gives him an embodied history (Noë, 2004). In fact we observe a case of anticipatory sense-making that is grounded in the bio-cognitive historical body:

> The clinical gaze is not that of an intellectual eye that is able to perceive the unalterable purity of essences beneath phenomena. It is a gaze of the concrete sensibility, a gaze that travels from body to body, and whose trajectory is situated in the space of sensible manifestation. […] 'theory falls silent or almost always vanishes at the patient's bedside to be replaced by observation and experience; for on what are observation and experience based if not on the relation of our senses.' (Foucault, 1973:148)

Experts are able to adapt to pivotal changes immediately. The doctor's actions are guided by the flow of his perception of affordances and the new affordances these actions cause.

In this example, inter-bodily dynamics are *not* representations or verbal embodiment with a gestural function; rather they are distributed inter-bodily dynamics with a pre-cognitive and pre-linguistic[17] direction anticipated beyond individual goal-orientation: as the team uses its cognitive powers on explicit hypothesis generating, it moves without reflecting on the movements. Since the goal is not pre-defined, the team members stop when they feel they are in the right place. The right place cannot be determined in advance, since the 'place' constantly moves simultaneously with the movement of the other individuals (Anderson, 2014). The successful movement is only successful due to the team's emergent capacity to interact as an emergent and self-organising system. The team's sensitivity towards environmental expressions allows it to anticipate potential problems without losing any cognitive power. Through detailed investigations of how a team interacts in a way that prompts the emergence of affordances, the analyses show that intentionality and problem-solving are shared activities that are maintained through the coordination of inter-bodily dynamics. From this perspective, explanation of individual agency is found beyond the individual agent. As mentioned in the introduction of chapter 1, an understanding of human errors requires a focus on both negative and positive feedback mechanisms. This case example reveals how a potential error cycle is anticipated. As constraints emerge within the system, it adapts flexible to the changes in the environment as it anticipates potential critical scenarios as a consequence of reduced visual access to the patient. As human error cycles are the main focus of interest, real-life examples of what inhibits error cycles are useful as, in this case, they underline the importance of coordinated team performance, and the function and possibilities of thinking in terms of distributed visual systems.

5.5 Case III: random manipulation: developing the visual system through probing-activities

5.5.1 Moving as seeing: an undeveloped visual system

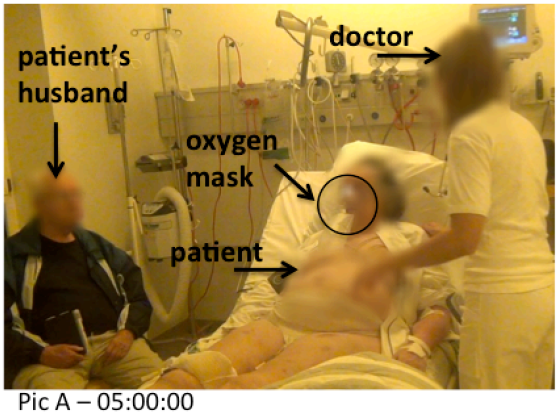
> The major difference between a thing that might go wrong and a thing that cannot possibly go wrong is that when a thing that cannot possibly go wrong goes wrong it usually turns out to be impossible to get at and repair.
>
> - Adams Douglas (2002:720)

A medical problem never emerges in a vacuum and the complexity of finding and solving problems increases as multiple expressive features penetrate the environment. In the

[17] Linell argues that: "cognition and communication involving language have precursors, which are *pre-conscious, pre-conceptual* and/or *pre-verbal"* (Linell, 2009:254).

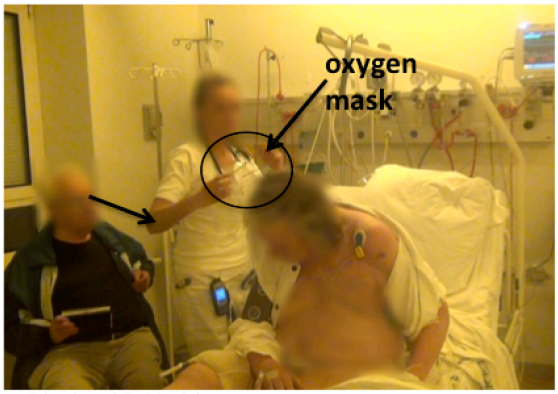
medical books, a problem is often presented in itself, whereas in real life multiple problems arise simultaneously and the order in which they should be dealt with, or how they should be dealt with is a situational issue.

Unlike the previous example, the following interactivity trajectory unveils an inadequate approach to such a challenge. A doctor enacts an action pattern that constrains both cognitive problem-solving and interpersonal relations with the patient. The doctor is about to complete a simple task that *cannot go wrong* in Adam's sense: she needs to listen to the patient's lungs to clarify if there is a murmur, but that requires that the patient sits and leans forward. However, the length of the wire attached to the oxygen mask that the patient is wearing prevents this simple standard task. As the patient cannot sit and keep on the oxygen mask at the same time, a dilemma emerges. What is easily completed in theory becomes impossible due to practical issues and it fixates the doctor who needs to come up with alternative solutions. First, the emergence of the dilemma is illustrated in the gallery below. This dilemma leads to continuous cycles of probing and fixation, which are analysed in relation to the doctor's level of perceptual richness.

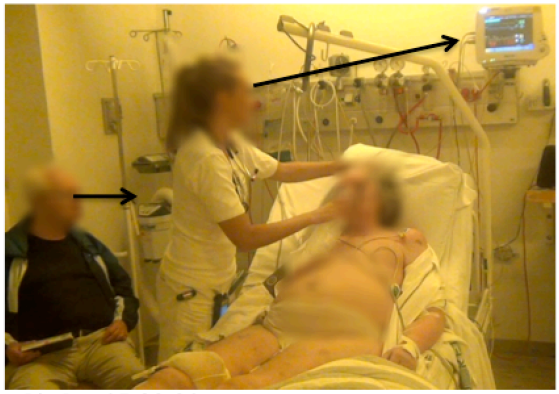


Pic A – 05:00:00
D: så skal vi lige
D: then we just need to

Pic B – 05:08:10
P: åh
P: oh



Pic C – 05:27:00



Pic D – 05:33:30

Red markings in the text indicate the verbal utterance articulated as the picture is taken

As the doctor gets the patient up in the bed in order to listen to her lungs, the patient's oxygen mask falls off (picture A + B). The doctor then walks around the bed to get the oxygen mask, which is indeed needed as the patient's oxygen saturation is low and causes the patient great trouble in breathing. The doctor puts on the mask and the patient forcefully falls back in the bed again in exhaustion. The doctor then observes the medical measurements on the screen above the patient's head (picture C + D). The dilemma is now explicit for all involved parties. (*a*) the doctor freezes, (*b*) the patient appears exhausted and (*c*) the patient's husband is attending to the doctor's behaviour. The patient is in a critical and unstable condition, and the dilemma causes a series of activities that are unpleasant for the patient and which troubles the doctor.

From a rational point of view, one relevant thing to do is to call for assistance to be able to listen to the patient's lungs. To get assistance to complete a very simple task is not usual in the ward, and the problem seems to be deferred by the doctor for a moment. Instead of calling for assistance immediately after the challenge is explicit, the doctor waits and walks around, doing what appears to be 'nothing,' when the context is taken into consideration. She appears fixated and meets what Steffensen et al. (forth.) describe as *suspended nexts,* or what Dewey (1910) characterises as a *forkedroad situation*.

While Steffensen et al. (forth.) and Dewey (1910) describe cognitive challenges in problem-solving as constraining situations, Wittgenstein follows up on this idea by arguing that the solution to such cases is just to do *something*: "If I have exhausted the justifications, I have reached bedrock and my spade is turned. Then I am inclined to say: "This is simply what I do"" (Wittgenstein, 1963:85e,§217).

The following shows the complexities that follow a situation where a suspended next inhibits the doctor to solve the problem (listen to the patient's lungs). Thus, working from the hypothesis that perception is dynamic and altered by an individual's interaction with the environment, a rational approach in order to expand the visual system seems to be related to action, or rather moving around within the environment. Theoretically, the situated environment in which the problem appears can be described as a spatial problem-zone in which one moves around to perceive the problem from as many new angles as possible and to contain embodied frustration in order to overcome the suspended next. This is what we observe the doctor is doing.

When the suspended next overwhelms the doctor, she fixates on procedures that do not contribute to the solution of how to overcome the fixation. As a consequence of reaching cognitive bedrock, she literally moves around and changes the visual array of the cognitive system. This is illustrated in the following event trajectory below:

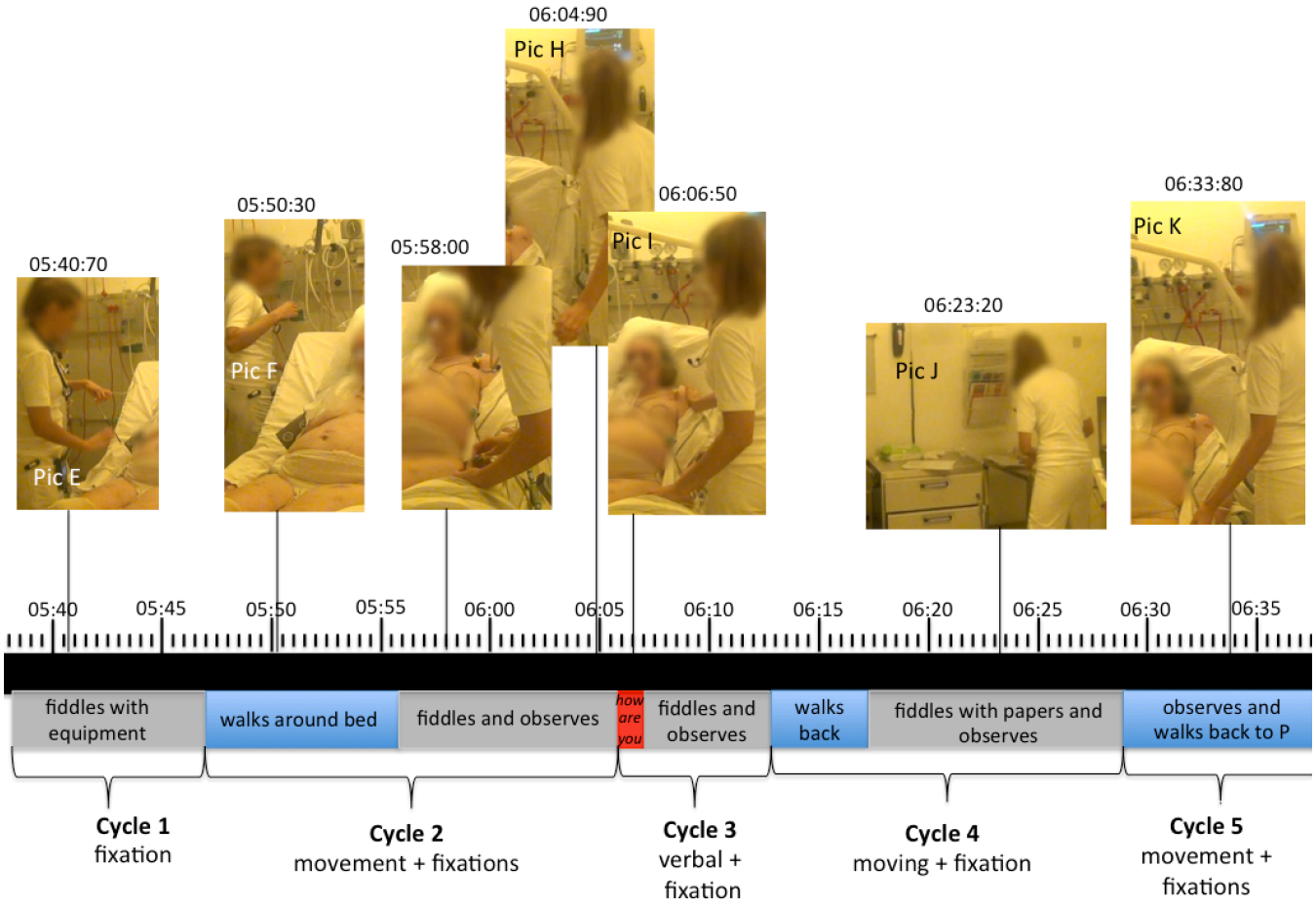


Figure 5.10: Moving in-and-out of a problem zone as cognitive manipulation

After the doctor has realised that she is unable to listen to the patient's lungs, she initiates various behavioural contortions and procrastinations when time is a limited resource. In figure 5.10 it is visualised how the doctor employs five action cycles in order to manage the increasing frustration within the cognitive system.

The first cycle involves the doctor's fiddling with the wires and attempt to arrange them nicely (see picture E). As the wires are the problem, this aesthetically organising does not contribute directly to the problem-solving. In another study, Steffensen et al., (forth) identify:

> a general tendency to impose an aesthetic order onto the physical layout of her surroundings […] To account for this dimension of [the participant's] cognitive trajectory, we define an aesthetic action as an action that (a) transforms the physical layout of the environment in order to make it more ordered, and (b) has no task-related, cognitive function. (Steffensen et al., forth:32)

In this context the neat reordering does not provide the doctor with a useful overview and she is prompted to do something to contain the frustration. She walks away and initiates a second cycle that involves a new combination of moving and fixed-procedure following:

she checks the workings of the equipment and gains information about the patient's medical condition. Specifically, the doctor walks behind the bed. Apparently she is not doing anything intentional (see picture F) and she walks back to the other side of the bed. As she moves, the visual system changes its perceptual array, but as the emerging properties of the system has not yet provided her with any functional affordances for proper action, she becomes fixated on procedures. She fiddles with the medical equipment attached to the patient's finger (see picture G) and observes the values on the screen (see picture H). Nothing appears to provide the doctor with decisive information and she fixates on the measurements for 5.5 seconds (see figure 5.10). The third cycle differs from the previous attempts to gain information. The doctor asks a verbal question: *how are you feeling* as she touches the patient's shoulder (see picture I). The patient utters: *°oh°* and the incomprehensive answer further indicates her critical condition. The response, thus, does not contribute to the process of figuring out what to do next. The doctor then resumes the fiddling with the equipment. The husband and the patient gaze momentarily at the doctor (see picture F + G), as they do not know what strategy the doctor is working on. The doctor has not yet been successful in getting out of the negative loop, and a fourth cycle of moving and fixation in order to manage the problem space is initiated. The doctor continues to seek a solution on her own. She turns away and walks to another corner of the room, where she fiddles with a paper record without looking further into its content (see picture J). Once again she stops, removes some papers, puts them back on the table and observes medical measurements on the electronic display. Time goes by and the doctor does not come up with solutions though she walks around in the ward. So far, her actions have not led to new insight and she moves away from the corner again. As she returns to the bedside, she hesitates before she once again observes the medical values on the screen (see picture K).

Every time the doctor gets back to the patient the challenge remains the same. Paradoxically, the doctor knows exactly what the local goal is (listen to the patient's lungs), but she is unable to attain it. After the oxygen mask falls off, the doctor spends a minute on walking around and repeating nested tasks: checking oxygen saturation etc. (see figure 5.10). Basically, there are only three solutions to the problem: (*a*) to call for assistance, (*b*) to get a longer wire or (*c*) to reorganise the position of the bed so that the wire is long enough. The doctor does not initiate any of these solutions, and moving in-and-out of the problem-space seems to be an escape strategy. Her moving around is identified as loops of fixation patterns that can be interpreted as a strategy of getting out of a literal problem zone. Moving around within the room allows for different perceptual possibilities. One way of developing a visual system is by trying to manipulate the situation in order to connect things in new ways, to perceive things from different angles, to understand alternative perspectives etc. In this case, intuition and frustration guide the doctor's actions, but the functional result remains absent and she wastes important time in a critical situation. The doctor's actions indicate an undeveloped medical visual system that is biased by local constraints (the length of the wire and the patient's unresolved medical condition) and non-local expectations of individual problem-solving. Within these

constraints, identification of functional solutions is inhibited even though the doctor clearly perceives the problem.

On the one hand there is no good reason for the doctor to move around in the room (behind the bed, around the bed and to the corner of the room), and yet on the other hand it makes sense to do something when bedrock is reached. When challenges emerge, frustration and stress often co-emerge. Logical and abstract reasoning (trying to think of a solution) requires stillness and a hierarchy with one isolated problem after the other: if/then sequences. In this situation the doctor needs to balance the heterarchy of multiple nested activities: taking care of the patient's emotional and medical condition, completing certain procedures (physical examination) and figure out how to deal with a sudden dilemma (completing a task that cannot be completed within the actual setting). The working hypothesis emphasised that moving around leads to an alteration of the visual system. Moreover, her moving around can be an indication of reducing complexity. When stress and frustration emerge as a result of incomprehensive initiatives, a natural bodily response to such emotional chaos is movement, an escape-pattern that gives the doctor time to contain the unbearable: not knowing what to do. Hence, the doctor's retrying-moving strategy is interpreted as a strategy for dealing with complexity (emotional, medical, interpersonal) and a strategy for manipulating the visual system to become able to perceive new affordances in a way that yields solutions. However, in this case the moving around and doing things do not expand her visual perception in a functional way. Fixation wins.

As the doctor does not call for assistance at an earlier stage, she enacts an activity pattern that allows the emergence of error cycles. Her actions serve as positive feedback mechanisms, and as she gets no closer to any solution, time runs and the patient suffers from pain and anxiety.

5.6 Conclusion: understanding visual systems

I have shown how perception is altered by an individual's ability to adapt flexibly to changes in the layout of affordances (Gibson, 1979/86; Noë, 2004). Thus, *purposeful movement* becomes an important strategy for manipulating the organism-environment system. In emergency medicine, moving in, out and around in problem zones, becomes an important strategy for exploring new solutions, solving problems and dealing with challenges and dilemmas. When challenges and hard problems emerge, roughly two interaction patterns are possible, (*a*) active, purposeful, and anticipative *manipulation* of the organism-environment system or (*b*) *fixation* identified as either paralysis or random movement.

Learning includes an exploration phase, an exhibition phase where various strategies are tried out and finally the skill is learned and the activity becomes more fluid, automatic and effortless (Merlaeu-Ponty, 2012; Dewey; 1910). When practitioners have different cognitive resources for diagnosing and treating patients, they use the pre-designed medical artefacts differently, their professional visual systems operate on the basis of experience, personality, situational factors and it leads to very different processes of behaviour. Also,

as shown in the first case, artefacts are not just used intentionally. Their mere object properties make a difference: they can serve as boundary markers, change the visual sensitivity and afford actions that are both functional and dysfunctional to the overall goal in these kinds of settings. I showed how the environment matters for visual perceptions and cognitive outcome. The materiality of the environment either constrains or expands a professional visual system. Some artefacts are tools that expand the peri-personal action space or enable certain tasks to be completed that could not be completed without the tool.

The analyses show how perception is a result of a sense-saturated visual system. The three cases showed the diversity of medical visual systems in diagnostic situations, due to the practitioners' various level of expertise and adaptive flexibilities. Thus, perception depends on a visual system that is a spatio-temporal constituted ability to perceive and prioritise certain solutions over others. In similar task-based situations (cases where error cycles are present) various strategies are implied. In case 1, the erroneous actions penetrate the cheese (cf. Reason's Swiss cheese model, chapter 1) in a way that results in human error (without anyone recognising them as such).

From a dialogical perspective, the team in the second case makes sense in a way that allows different individuals to co-act. Analysis of fine-scaled coordination and attunement of whole-bodied interaction through reciprocal adaptation reveils the core dynamics of human coaction. By emphasising the spatio-temporal, dialogical and embodied aspect of sense-making, I showed how the medical team constitutes a shared intentionality through dialogical sense-making based on, in particular, the doctor's developed visual system. Specifically, the doctor is a skilled and experienced doctor, and his professional visual system is shaped by experience, knowledge and real-time dynamics. As he initiates his movements, he actively manipulates the organism-environment system to sustain the best visual system. Due to his embodied historicity, he knows how (Ryle, 1949) to be in the right place, without consciously considering where the right place is. His actions are not explained as accidental and random but rather sense-saturated. Merleau-Ponty argues that perception is less about explicit calculation than understanding movement:

> If I possess the habit of driving a car, then I enter into the lane and see that "I can pass" without comparing the width of the lane to that of the fender, just as I go through a door without comparing the width of the door to that of my body […] Places in space are not defined as objective positions in relation to the objective position of our body, but rather they inscribe around us the variable reach of our intentions and our gestures. To habituate oneself to a hat, an automobile, or a cane is to take up residence in them, or inversely, to make them participate within the voluminosity of one's own body […] One can know how to type without knowing how to indicate where on the keyboard the letters that compose the words are located. (Merleau-Ponty, 2012:144ff)

If perception is action, then moving toward something is a continuous process of being in the right place. The nature of medical vision is explained as a visual system that not only deals with the embodied experience, but a distributed experience, that transgresses individual embodied 'tacit' knowledge. Seeing is a whole-bodied sensorimotor skill that

enables the doctor to adapt flexibly to the changes in the environment. An average person perceives things differently than the medical expert and hence he would move differently, placing himself in another position etc.

The excerpt above supports Noë's (2004) hypothesis based on the critique that conventional literature on perception mistakenly has assumed that phenomenology is about structures in the visual field. Rather, he proposes: "We experience the world as unbounded and densely detailed because we do not inhabit a domain of visual snapshot-like fixations. […] Vision is active; it is an active exploration of the world" (Noë, 2004:72). The doctor is able to apply his clinical abilities in a social practice of medical problem-solving. Sense-making is brought to life *in situ* (Linell, 2009:222), but it has often retrospectively been explained as a logical and mechanistic process as if it happens in a vacuum with clear boundaries and a start and an end:

> Of course, when the road has been travelled, we can glance over it, mark its direction […] as if there had been pursuit of an end. […] But, of the road which was going to be travelled, the human mind could have nothing to say, for the road has been created pari passu with the act of travelling over it, being nothing but the direction of this act itself. (Bergson, 1911:51)

According to Bergson, linear causation is behind us, and the creative nature of human life is in front of us. Following Dewey (1910) a cognitive system is enabled to act functionally according to the changes in its environment due to the information the system has gained over time. In other words, the team's coordination is sense-saturated (Steffensen, 2013) and different from random movements. Random action does not necessarily manipulate anything, thus timing, coordination and coaction are fundamental criteria for successful and purposive manipulation and recalibration. Such criteria require that we investigate the adaptive flexibility of a cognitive system rather than behaviour of individuals. Knowing what to do, where to be, where to look and what to look for can be related to a system's degree of automaticity and fluidity of actions. Ryle (1949) argues against the idea that there is a causal dependency between knowing *that* and knowing *how*. He argues, that for an individual to know how to do something and to do it, has nothing to do with knowing the facts about how to accomplish it (Ryle, 1949) and as such the team's movement is an embodied, tacit and skilled knowledge.

As emphasised in the beginning of this chapter, visual systems are shaped by historically repeated interactions. By engaging in situations with repetitive features, the visual system is enhanced and primed to see certain actions and situations as affordances for problem-solving (Goodwin, 1994; Gibson 1979/86). With a famous saying from Bernstein the enabling conditions are grounded in *repetition without repetition* (Bernstein, 1996:204). This statement refers to a system's ability to see proper solutions in a wide range of task conditions where a basic activity is repeated but the actions are adjusted and adapted to the situation. In this perspective, the goal is not to slavishly train stable and nearly identical stimuli, muscle forces, movements and other actions. Rather, the aim of training and education is successful realisation of values that is solved in ecologically real environments, in this case diagnostic processes in emergency settings,

where practitioners are subject to unpredictable changes (Ito, 2011). It is a plausible interpretation that because the doctor in the second case has been involved in a number of emergency situations where the patient's condition suddenly worsens, his embodied historicity of being alert, provides him with an ability of seeing small scale changes that reduces his visual array, no matter how different such small scale changes might appear. Though each particular situation varies in many respects, the task (and momentarily the constraints) often takes on similar appearances. Repetition without repetition is sense-saturated (Steffensen, 2013), and allows for flexible behaviour in goal realisation processes. If the movements were not sense-saturated, the goal would not be achieved in such a smooth and coordinated way. The team moulds the optic array and their joint movement serves as a negative feedback mechanism which successfulness is defined by its anticipatory intentions that facilitates fluid and smooth task performance. The successfulness of this team relates to its cognitive abilities to align its verbal utterances (a cognitive agenda of hypothesis generating) with movement (to secure visual contact with the patient). Much seem to be encountered and anticipated in a way that feeds back on the interaction so it never appears to be a problem at all. The claim, that the doctor's successful, highly coordinated anticipatory actions are based on repetitions without repetitions, is supported with a counterexample where a novice doctor moves without any purposive or convincing strategy, and where fixation and frustration prompt her to do just *something*. The final case shows the operations of an undeveloped visual system where the abilities for solving a problem do not match the perceptual complexity of the situation. Thus, dilemmas arise, problems emerge and the practitioner finds herself in a *forkedroad situation* (Dewey, 1910) that prompts her to anticipate possible changes of plans. Frustration emerges as a result of positive feedback mechanisms within the cognitive system. However, the doctor's moving-strategy is an embodied way of trying to manipulate the situation and move out of a problem zone, though with an unsuccessful result.

Understanding the processes of becoming a master within a discipline is the key to facilitate and scaffold learning. If repetitive situations and task performances reshape our perception and make professionals revise their concepts and thinking in general (Kirsh, 2013; Noë 2012), we need to show *how* this happens. Importantly, developing a visual system can happen in many ways: through intuition-based probing, as in the latter case, but also by letting an experienced practitioner guide a novice (facilitation). In the latter proposal, the visual system becomes efficiently informed and developed (see also chapter 9.3-9.3.2). Finally, visual perception has less to do with processes of representation than being aware of how and what can be manipulated (Gibson, 1979/86; Noë, 2004; 2010; Pedersen and Steffensen, 2014).

6. Procedures and the diagnostic process: anamnesis and physical examination

6.1 The function of procedures

This chapter investigates how the role and use of procedures are related to the prevention or emergence of human error cycles. By so doing, it investigates how doctors manage to balance multiple expectations during history taking and physical examination by relying on procedures, guidelines and medical protocols. It further questions the systemic function of such tools and it scrutinises what makes them vital in some diagnostic processes and dysfunctional in others. Understanding how procedures on the one hand scaffold medical decision-making, and, on the other constrain such processes is crucial to enhance patient safety and for developing suitable educational practices.

Coming up with a valid diagnosis in the emergency ward involves an assessment process where various clinical methods, procedures and protocols are used. Overall, the medical team needs to balance both medical and interpersonal aspects in interaction. Specifically, they are required to (*a*) collect data about the patient's medical history, real-time problems and experienced symptoms (anamnesis), (*b*) to examine the patient via palpation and/or auscultation, (*c*) to come up with a diagnosis and a plan for further treatment and (*d*) to register and document relevant information in the electronic medical record (Miller and Sim, 2004). This chapter zooms in on the initial part of the diagnostic process, and focuses on how doctors manage anamnesis and in one case also physical examination by relying on procedures in various ways.

During anamnesis the practitioner is expected to cover specific areas of the patient's general situation and document the results in the electronic record. The procedures in anamnesis cover information about: reason for hospitalisation, the patient's actual

situation, circumstances related to infectious diseases, work situation, travels abroad, allergies, previous medically history, actual medical issues, information about organ systems and related medical issues (dizziness, headaches etc.), tobacco, drug and alcohol intake, social circumstances and functional level. Besides the anamnesis (the patient's narrative) the practitioner needs to document information based on objective examination. Such information covers the practitioner's interpretation of the patient's general health condition (state of nutrition, age appropriate condition, skin colour, temperature, level of consciousness etc.). Multiple clinical conditions must be documented in the record. Some of the conditions are based on observation and others are based on measurements and physical examination.[18]

During anamnesis there are several nested tasks the doctor must attend to in order to accomplish the task efficiently and dialogically. First, the doctor needs to make the patient feel as comfortable as possible and establish trust that enables him to generate links between the perceived medical situation, objective measurements and the patient's narrative. Second, as resources are limited, the healthcare practitioner must continuously prioritise and guide the patient toward the medical relevant points in the interaction. Third, the information must be interpreted in relation to the real-time medical measurements and further translated into medical categories that can be shared with other healthcare professionals. As will be shown in the analyses, it is crucial that the practitioner picks up relevant information in a way that guides action and yields cognitive results. Within the emergency ward multiple written protocols are developed to structure the respective clinical tasks in the overall diagnostic process. Such protocols need to be followed in practice and their functions have been discussed in various studies. For instance, Angeli (2015) emphasises: "Participants memorized protocols and guidelines and drew on this memorized, professional knowledge to treat patients […] Protocols allowed participants to reduce cognitive workload and focus on the patient" (Angeli, 2015:28). Based on an ethnographic study Angeli emphasises that without protocols the organisation would break down. While acknowledging the importance and necessity of procedures and protocols I also challenge the profound positive and simplistic understanding of such performance aids and I discuss the consequences of relying on such procedures in various contexts. Finally, I discuss procedures in relation to conventional understandings of interaction and I emphasise the importance of dealing with embodied resources in procedure following situations.

In this context procedures encompass standards originating from protocols and clinical and communicative guidelines. Protocols and medical guidelines have been defined within the literature as "official standardized treatment plans" (Angeli, 2015:3). Further, each patient condition has its own protocol, e.g. cardiac arrest, respiratory arrest, sprained ankle (cf. Angeli, 2015). Communicative guidelines refer to procedures often learned outside the classroom and they are not regulated in the same way as medical protocols. However, they

[18] This information is based on internal instructions. I am not allowed to attach the original written instructions for internal use at the ward.

function in the same way and provide a set of fixed expectations about proper performance. Angeli (2015) argues that such expectations facilitate communication as scripts and protocols structure responses.

During these activities, good doctors ensure that the patient is aware of the direction, intention and results of the nested tasks. Accomplishing the cognitive task (anamnesis) and at the same time balancing nested tasks, depend on procedures. Again, the way procedures are embedded and relied upon relates to medical expertise and general experience. In emergency settings, a great deal of prior experience is distilled in action procedures that are constructed ahead of time in the sense that they serve to structure future situations. In a similar vein Hutchins (1995a:165ff) discusses how "precomputations are saved representational structures that transform the nature of the task performance […] Each of these precomputations is a way of building local invariants into the structure of the tools that are used in the performance of the navigation task." Likewise, at the emergency ward, expectations and rules for behaviour serve as local invariants intended for structuring the clinical encounter. For instance, doctors and nurses are trained in structured medical history taking and they are taught consultation skills, communication strategies and related standard operating procedures such as ISBAR[19] and ABC-procedures.[20] Angeli (2015) argues that within emergency medical services communication (EMS), healthcare professionals collaborate by relying on non-situational professional memory "which is comprised of textbook knowledge and protocols that EMS professionals learn during training. Collaborative memory refers to the process of individuals working together on the same task, remembering pieces of information, and gathering that information together to complete an activity" (Angeli, 20015:10ff). Such memory aiding protocols are designed to release cognitive powers and to automatise action and perception with a minimum of cognitive effort in situations where cognitive resources are scarce, for instance due to a high level of stress or time pressure. Further, the aim is to standardise and automatise outputs to narrow the risk of human errors. Thus, inherent in the procedures is a set of pre-made decisions and action plans that leave minimal room for reflection, but a huge responsibility for rule following. Procedures, just as tools and abstract information structures, serve many purposes depending on how they are managed. While the use of such aids releases cognitive power and guides practitioners to achieve their goals, analysis reveals that they also constrain situational sensitivity and paralyse practitioners in situations where the unexpected happens – and at worst, increase the risk of human error.

Overall, the current chapter pivots on challenges in anamnesis and physical examination that relate to competing requirements to balance (*a*) efficient problem-solving with a dialogical and caring approach, (*b*) invariant procedures with adaptive flexible behaviour

[19] ISBAR is an abbreviation for: Identification, Situation, Background, Analysis, Advice (*Råd* in Danish). The protocol has been developed by the Danish Society for Patient Safety.

[20] ABC is an abbreviation for: Airways, Breathing, Circulation. This protocol serves as a memory aid when dealing with the unresponsive patient. The three functions are vital to the maintenance for the patient's life and they constitute a priority for assessment, diagnosis and treatment.

and (*c*) system expectations with patient requirements. The chapter uses two cases to investigate how the use of procedures results in functional or dysfunctional outcomes and how they relate to the emergence or prevention of error cycles. Specifically, the cases show how cognitive events emerge and are managed as practitioners use procedures, tools and their bodies (*a*) to organise and structure the patient narratives, (*b*) to gain precise information, (*c*) to structure memory processes, and (*d*) as a means to reduce patient insecurity.

The first case is an example of best practice. It shows how an experienced doctor manages procedure following in a flexible way that allows for creative and dynamical decision-making as he uses his body as a dynamical tool for adapted and situated procedure following. The second case, in contrast, illustrates how a novice doctor is forced to replace a task heterarchy with a rule-following hierarchy by prioritising standard procedures over local demands for interaction.

Overall, the cases draw on all three perspectives within the interactivity framework. For instance DC and CEA are used to investigate how the practitioners rely on non-local generated procedures and norms to extend and scaffold decision making in situated and artefact-rich interaction. Furthermore, dialogical approaches afford elaboration of micro-sociological findings as for instance how patient and practitioner are unable to coordinate turn-takings. Finally, CEA and ecological psychology show how functional perception is shaped by individually embodied procedures and situated rule-following.

6.2 Case I: enacting and discarding procedures

This case emphasises how procedures can be secondary to patients and modulated to fit the overall situation. That means that standard and fixed procedures are oriented to, discarded or adjusted as a result of an experienced practitioner's flexible adaptive behaviour. Because procedures relate to standard situations, their general applicability inhibits sensitivity to situational particularities and deviances if they are followed slavishly and function as a fixed hierarchy for actions. The following case shows how an experienced doctor is able to balance procedures, medical knowledge and emerging affordances all at once. Attention is given to the points in the cognitive trajectory where the doctor realises that the working hypothesis is insufficient and a new strategy is needed; these points are characterised as insights or breakthroughs (Steffensen et al., forth.) that have consequences for what happens next. Specifically, attention is given to (*a*) how the doctor gets information that enables diagnostic outcome as he meshes anamnesis with physical examination, (*b*) how he tests hypotheses by linking the patient's knowledge to medical procedures and perceptual insights achieved through whole-bodied interaction, (*c*) how he guides the patient's narrative by indicating what is irrelevant in order to reach a diagnosis efficiently and professionally (*d*) how he uses the patient as an important cognitive resource as he relies on his own body as a dynamical tool for adapted procedure following and finally (*e*) how procedures are part of his automatised, skilled behaviour in a way that releases cognitive powers for situational cognition that leads to functional task

performance. Below is an illustration of the setting.

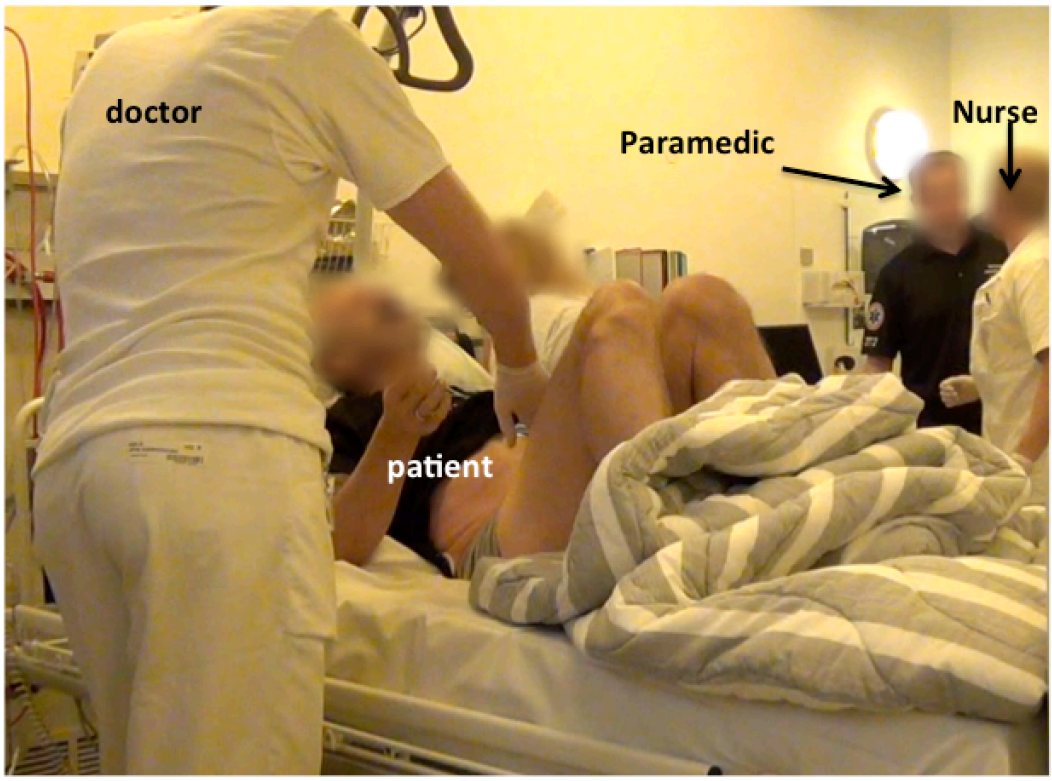


Figure 6.1: Overview of the layout: the abdominal patient

6.2.1 Beyond fixed procedures: meshing anamnesis with physical examination

As we enter this conversation, the doctor has just received information from the ambulance team that handed the patient over to the medical team. The doctor is an experienced young man and the patient is a middle-aged man with no significant medical history. Under the transportation to the hospital he has complained about severe stomach ache and diarrhoea and he has had several intense stomach cramps. The patient has a very low pulse rate, which is discussed several times during his stay in the ward. When he arrives he is still in great pain and he has difficulties breathing, which impedes his speech and his power of concentration. The medical team initiates the diagnostic task and works with an abdominal patient hypothesis.

Transcript 6.1[21]
Duration: 01:49:80 minutes

DANISH ORIGINAL

1. 03:55:80, D: KAN DU PRØVE AT PEGE PÅ MAVEN HVOR DET GØR ONDT HENNE
2. 03:57:80, P: °°.h°°
3. 03:58:90, D: ER DET HER ↑OPPE
4. 04:00:00, P: ja (.) det der der det er det (.) det er ikke dernede det er fint (.) min min (xxx) det er fint (.)
5. 04:06:60, D: °°det er fint°°
6. 04:07:60, ps. (3.3)
7. 04:10:90, D: ER DET OPPE I BRYSTET ELLER ER DET NEDE I MAVEN DU HAR ONDT=
8. 04:12:90, P: =det er oppe i brystet
9. 04:13:90, D: DET ER OPPE I BRYSTET (.) HAR DU SLET IKKE ONDT HER NEDE I MAVEN
10. 04:17:70, P: ne:j .h (.) jeg er holdt op med at ta:ge (.) medicin (.) øh (.) søndag middag (.) de de:r øh Pinex
11. 04:26:50, D: ↓ja
12. 04:27:00, P: og de f. (x[xx)
13. 04:29:60, D: [DU HAR HAFT MASSER AF DIARRÉ ik os
14. 04:30:90, P: ja: øh ja
15. 04:32:20, D: gennem det sidste døgn
16. 04:33:10, P: narj (.) siden klokken to i nat (.) der har jeg men det har ikke været det har ikke været sådan noget (.) vandligt
17. 04:39:20, D: nej
18. 04:40:00, P: men det (.) det er gået nemt .h
19. 04:42:90, D: men det er jo maven ik
20. 04:44:00, P: jo
21. 04:44:50, D: nu siger du du har ondt i brystet
22. 04:46:30, P: det (.) kramper heroppe
23. 04:47:60, D: det kramper her
24. 04:48:70, P: ja
25. 04:48:90, D: og her
26. 04:49:60, P: ja og den ene skulder også
27. 04:51:60, D: og den ene skulder (.)↓o:kay
28. 04:52:90, ps. (1.0)
29. 04:53:90, D: har du ondt heroppe i brystet (touching)
30. 04:55:50, ps. (1.0)
31. 04:56:50, P: ne:j .h
32. 04:57:20, D: nej (.) har du udstråling til armen (touching)
33. 04:59:00, P: ne:j det synes jeg ik[ke
34. 04:59:70, D: [har du åndenød (.)
35. 05:01:50, P: når det kramper så øh (.) [så øh så har jeg svært ved at trække vejret i bund
36. 05:02:80, D: [så kramper det
37. 05:05:10, D: ja (.) og så stråler det op ud til skulderen heromme bagpå
38. 05:08:20, P: ja
39. 05:08:80, D: okay (.) så prøv at peg med fingeren hvor det det gør mest ondt
40. 05:12:70, ges:(P points)

[21] *PM* is an abbreviation for paramedic; *ges* is an abbreviation for gesture.

41. 05:14:80, D: der tværs over o:kay (.) ja men vi bestiller et EKG for en sikkerheds skyld men mit umiddelbare indtryk er at det i:kke er noget kardionalt (.) men nu må vi jo lige se
42. 05:22:60, PM: ja
43. 05:23:00, D: der er også visse point må man sige til noget abdominalt
44. 05:26:00, PM: (xxx)
45. 05:28:10, D: ja
46. 05:29:00, P: der er pissekoldt mand (.)
47. 05:31:50, D: ja (.) vi skal nok få varmet dig op
48. 05:33:10, ps. (2.1) (D covers P with the duvet)
49. 05:35:20, D: prøv at lægge benene ned
50. 05:36:30, ps. (2.5)
51. 05:38:80, D: har du haft feber derhjemme (.)
52. 05:40:30, P: ja:eh lige f jeg sad og sf ja (.) jeg svedte af helvede til

ENGLISH TRANSLATION

1. 03:55:80, D: PLEASE POINT AT YOUR STOMACH WHERE IT HURTS
2. 03:57:80, P: °°.h°°
3. 03:58:90, D: IS IT UP ↑HERE
4. 04:00:00, P: yes (.) that there that that is (.) it is not down there that is fine (.) my my (xxx) that is fine (.)
5. 04:06:60, D: °°that is fine°°
6. 04:07:60, ps. (3.3)
7. 04:10:90, D: IS IT UP IN THE CHEST OR IS IT DOWN IN THE STOMACH YOU FEEL PAIN=
8. 04:12:90, P: =it is up in the chest
9. 04:13:90, D: IT IS UP IN THE CHEST (.) YOU DO NOT FEEL ANY PAIN DOWN HERE IN THE STOMACH
10. 04:17:70, P: no: .h (.) I just stopped taki:ng (.) medication (.) eh Sunday midday (.) tho:se eh Pinex
11. 04:26:50, D: ↓yes
12. 04:27:00, P: and they f. (x[xx)
13. 04:29:60, D: [YOU HAVE HAD A LOT OF DIARRHOEA right
14. 04:30:90, P: ye:s eh yes
15. 04:32:20, D: over the last 24 hours
16. 04:33:10, P: no: (.) since 2 am this night (.) then I have but it has not been it has not been kind of (.) watery
17. 04:39:20, D: no
18. 04:40:00, P: but it (.) has been coming easily .h
19. 04:42:90, D: but that is the stomach right
20. 04:44:00, P: yes
21. 04:44:50, D: now you are saying that you have pains in the chest
22. 04:46:30, P: it (.) cramps up here
23. 04:47:60, D: it cramps up here
24. 04:48:70, P: yes
25. 04:48:90, D: and here
26. 04:49:60, P: yes and the one shoulder as well
27. 04:51:60, D: and the one shoulder (.)↓o:kay
28. 04:52:90, ps. (1.0)
29. 04:53:90, D: do you have any pain up here in the chest (touching)
30. 04:55:50, ps. (1.0)
31. 04:56:50, P: no: .h
32. 04:57:20, D: no (.) do you have any pain radiating to the arm (touching)

33. 04:59:00, P: no: I do not think [so
34. 04:59:70, D: [any difficulty breathing (.)
35. 05:01:50, P: when it cramps then eh (.) [then eh I have difficulty breathing fully
36. 05:02:80, D: [when it cramps
37. 05:05:10, D: yes (.) and then it spreads up out to the shoulder on the backside
38. 05:08:20, P: yes
39. 05:08:80, D: okay (.) try to point with your finger where it hurts the most
40. 05:12:70, ges: (P points)
41. 05:14:80, D: across there o:kay (.) yes but we order a EKG just to be sure but my immediate impression is that this is no:t something cardiologic (.) but now we will wait and see
42. 05:22:60, PM: yes
43. 05:23:00, D: there are some points you must admit to something abdominal
44. 05:26:00, PM: (xxx)
45. 05:28:10, D: yes
46. 05:29:00, P: it is freezing man (.)
47. 05:31:50, D: yes (.) we will get you warm again
48. 05:33:10, ps. (2.1) (D covers P with the duvet)
49. 05:35:20, D: please put your legs down
50. 05:36:30, ps. (2.5)
51. 05:38:80, D: did you have any fever at home (.)
52. 05:40:30, P: yea:eh just f I sat and sf yes (.) I was sweating like hell

Right after the doctor has greeted the patient, he asks him to *show* specifically where it hurts: *PLEASE POINT AT YOUR STOMACH WHERE IT HURTS*, line 1. The history taking is immediately initiated in a way that requires the patient to use a whole-bodied approach that enables precise identification of the real-time medical problem. As the patient locates his pain with his hand, he responds with an embodied deictic rather than with a linguistic category such as “the chest”, “breast”, “upper body” or “the right side”. The answer turns out to be tricky as the original starting point (abdominal medical issues) now is expanded to incorporate further symptoms and hence even more possible and complex cause-effect relationships. Thus, the moment the patient touches his chest is identified as an event pivot that prompts the doctor to clarify, re-evaluate and determine whether the patient suffers from one or the other medical condition. Specifically he tests the two hypotheses 6 times during the next excerpt (see figure 6.2)

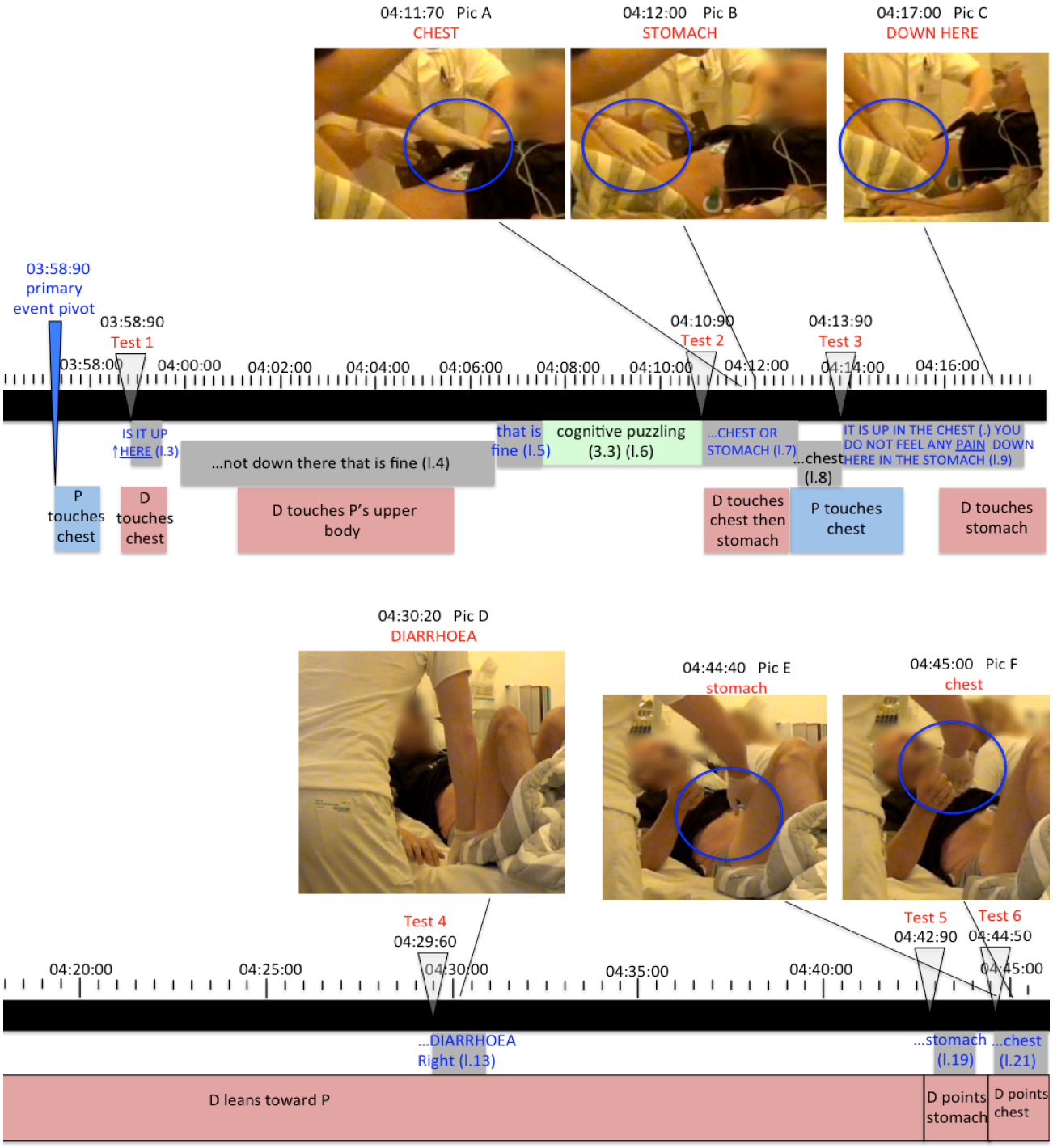


Figure 6.2: Embodied procedures in hypothesis generation

The figure shows how the doctor tests two competing hypotheses as he relies on embodied expertise. As he re-evaluates the medical situation he meshes physical examination and history taking. This process is defined as a clarification task, methodologically identified as a breakthrough phase in which the doctor links new insight with non-local information, real-time perceptions and medical expertise.

First, the doctor double-checks that the patient is sure about the location. He poses a

counter question *IS IT UP ↑HERE* (line 3). The emphasis on the *↑HERE*, and the rising intonation indicate an element of surprise. As the patient confirms, the doctor acknowledges this new information and a lapse of 3.3 seconds emerges (line 6) and the doctor freezes. The remarkably long lapse indicates a cognitive puzzling and marks a transition phase in the interactivity trajectory. Before the lapse, the patient and the doctor engaged in history taking. However, as the doctor after a first validation test (see figure 6.2), realises that the situation is not as straightforward as assumed, the realisation serves as an affordance for re-evaluation. During the 3.3 seconds the doctor's cognitive puzzling has consequences for how he continues the task performance. After the lapse a different strategy is enacted and the doctor meshes history taking with physical examination to validate and generate hypotheses about medical issues. As the doctor meshes the two tasks he is able to contrast the patient's narrative with perceived information achieved through physical examination.

The doctor tests the patient's localisation of pain area a second time by giving him the choice to articulate which body part (the chest or the stomach) is related to his pain (line 7). When the doctor explicitly asks the question he also uses his own medical expertise to identify and locate the specific areas that define the areas of the stomach and the chest respectively by pointing specifically to each area with his fingers (see picture A and B below). When the doctor selects concrete areas of the body and demarcates them through touch, he also allows the patient to relate the area of touch to the area of pain in real-time, rather than relying on pure memory.

The doctor relies just as much on the information he sees and senses as what he hears. To paraphrase Foucault (1973), he uses 'the ear of his finger' in direct perception of the patient's symptoms. The information he perceives by gazing at the patient's deictic gestures and locations of touch, prompts him to work with two competing hypotheses concerning two medical scenarios, with two different patient categories: the abdominal patient as initially hypothesised, and the cardiologic patient as hypothesised through the interaction with the patient. As the doctor now works with two competing hypotheses, he systematically investigates which one seems more evident than the other. As will be shown below, he does this by (*a*) using the patient a cognitive resource, (*b*) using his own body encompassing touch, gesture, voice, gaze, and posture to gain comprehensive information about the patient's medical condition, (*c*) meshing examination and anamnesis, and (*d*) explicating reasoning during the task performance.

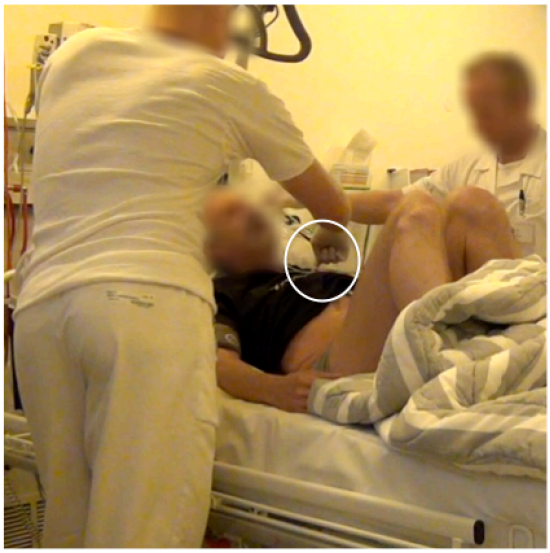
General procedures in the diagnostic process dictate structural steps; for instance to complete anamnesis before examination, and to follow general guidelines for information retrieval. According to this procedure, the first step is to welcome the patient. However, this doctor barely introduces himself before he meshes anamnesis, with examination. Picture C illustrates how the doctor examines the patient's stomach as he tests the medical claim a third time: *YOU DO NOT FEEL ANY PAIN DOWN HERE IN THE STOMACH*. He examines the abdominal wall with his fingertips in order to identify possible abdominal tenderness. The patient is encouraged to explicate his experience as the doctor compares it to medical measurements (the result of the palpation). The doctor is experienced and this

shows in his adaptive behaviour. First, he relies on what he perceives *in situ* and he is able to adapt to the situation by meshing two tasks, as this proves useful according to the situation. However, no procedure in the ward accounts for the function of meshing tasks; rather they dictate an action hierarchy, for instance following protocols and procedures for the abdominal patient and the cardiac patient, respectively. Further, such procedures are saturated with what Linell (2005) defines as the written language bias. Communicative procedures within the anamnesis process are developed with an exclusive focus on verbal information retrieval, for instance which questions to ask in a pre-defined sequential order. In the following, it is exemplified how the doctor both relies on standard medical procedures as he asks standard questions and guides the patient's narrative and how he also relies on inter-bodily dynamics as he uses gaze, touch and gestures as crucial means in anamnesis. While the doctor's embodied task performance is functional and effective, it is rarely discussed comprehensively in educational programmes or protocols.

As the doctor is not yet convinced of which of the working hypotheses should be excluded, the highest priority in the diagnostic task is to clarify which body part the medical condition relates to. This prioritisation is seen in the way the doctor balances multiple constraints in the situation and specifically in (*a*) the way he guides the patient's narrative, (*b*) how he relies on standard procedures to clarify cause-effect relations, and (*c*) how he circumvents fixed procedures by relying on embodied resources and inter-bodily dynamics. By so doing, the doctor adapts to the situation by initiating what appears to be the most efficient move in order to achieve the goal as efficiently and precisely as possible without losing sensitivity and without performing in a recipe-like fashion.

When the patient embarks upon a narrative concerning his intake of Pinex, (line 10+12), the doctor interrupts, changes the subject and tests the medical symptoms in relation to previous medical conditions: *YOU HAVE HAD A LOT OF DIARRHOEA right*. And again later on: *but that is the stomach right* as he touches the domain of the stomach with his fingers to relate his question to a physical area that can be felt immediately by the patient (picture E). The patient confirms that his diarrhoea relates to problems with the stomach. And the doctor then explicates what appears to be a medical inconsistency as he comments: *now you are saying that you have pains in the chest* (line 21) (figure 6.2, Picture F).

Again, the patient uses his hand to locate where it hurts as he utters: *it (.) cramps up here*, (line 22). In what follows, the doctor repeats and puts emphasis on the: *up <u>here</u>*, (line 23). Rather than referring to a distinct part of the patient's body (up *there*), the doctor puts himself in the position of the patient. By touching the patient's chest as he utters *up <u>here</u>* he minimises the distance between them, because he meshes the patient's explanations with his own perceptions through touch. Finally, the doctor validates the seriousness of the patient's chest pain symptoms by asking a few standard questions as he touches the physical body areas to underline the movement of pain, the directions of pain and the precise location within the body part (see picture G, H and I).



Picture G– time: 04:58:10
l. 32, D: no (.) do you have any pain radiating to the arm

Picture H – time: 05:00:00
l. 34, D: [any difficulty breathing (.)

Picture I – time: 05:14:10
l. 40, (P locates the area with his hand)

This embodied strategy affords a dynamic, interactive and participatory behaviour from the patient as the doctor asks the patient, not to tell, but to *show* where it hurts (line 1 and 39). It is complicated to articulate the feeling of pain and its exact location, thus other strategies

– such as pointing and touching - can turn out to be helpful.[22] Interestingly, the patient does not immediately recall the location and it takes him a moment to identify the right location (see picture I). For 8.5 seconds the patient moves the tip of his fingers back and forth on his stomach to narrow down the area. Because he is able to use his body actively in the diagnostic process, the relevant location is prompted through actions (a felt place) rather than through pure mental simulation. Touching is a means for enacting non-local experience as real-time perception is linked with bodily experience (Noë, 2004; 2010). The patient identifies not only the area of pain, but also the direction and movement of the pain he perceives. This approach equips the doctor with valuable information, since horizontal pain movements are related to some cases of illnesses and not to others. The approach is useful and provides the doctor with vital information that makes him change his current hypothesis once again. Initially the abdominal hypothesis that originated from background information from the paramedical team was replaced with the cardiac patient hypothesis that was generated on the basis of the patient's localisation of the pain in his chest. Finally, after gaining further insight in the patient's narrative combined with physical examination, the symptoms point in the direction of an abdominal medical condition (see line 41). Rather than being an unreliable patient, it is common that the average patient is not aware of the exact boundary between physiologically defined body parts, as for instance the exact domain of the stomach and the chest, the sternum and the ribs etc. Thus, rather than relying on verbal language as the only means for history taking, the doctor draws on his experience and uses his body as a coordinating tool. Such whole-bodied approach is useful in reaching efficient and relevant information about the patient's medical situation. However, standard procedures in diagnostic tasks are biased by the view that language is the primary tool for representing information. This doctor actively searches for answers by relying on inter-bodily dynamics. As the patient is an integral part of the cognitive system, the diagnostic process is characterised by joint interactivity rather than individuals engaging in question-answer sequences. This approach enhances efficiency and coordination in the diagnostic process and it leads to a useful result: as the patient locates the pain across the stomach, the doctor perceives just enough information to reach a preliminary decision and move on, (line 41). The doctor orders an EKG, as he has not been able to eliminate the possibility of cardiac problems, even though he is convinced that the medical condition relates to abdominal issues. The breakthrough leads to a new, broader cognitive focus. The doctor asks general questions and initiates obligatory examination procedures.

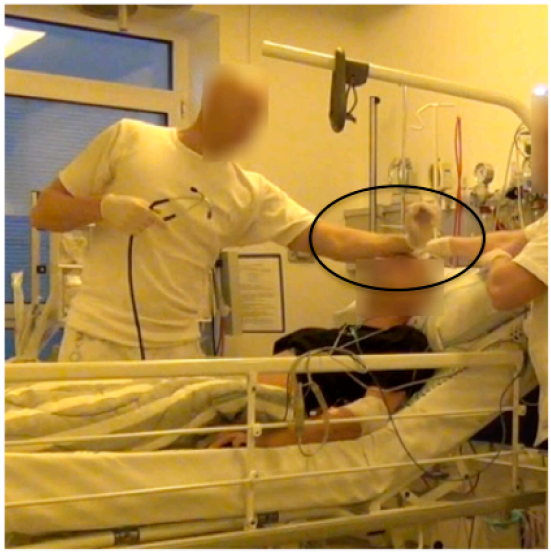
However, as there are standard procedures that must be followed - some information is always needed - others are optional. When the patient grabs the doctor's arm as he utters that he is freezing (see picture L), the doctor is prompted to check the patient's

[22] There are examples of guidelines that include the use of gestures, for instance in a chapter on palpation: "Ask patients with abdominal pain to point to the area of greatest pain. Then reassure them that you will try to minimize their discomfort and examine that point last" (Ferguson, 1990:474). However, in such interpretations gestures are used as a means for sequential information gathering rather than dynamical possibilities for coaction.

temperature, he relies on his own body temperature to decide if the patient's temperature is critical. However, his first attempt is constrained by the latex gloves he wears (see picture M), and he immediately uses the backside of his wrist to perceive the warmth directly (see picture N).

Picture L – time: 05:31:40
l. 46, P: it is freezing man (.)

Picture M – time: 05:39:50
l. 51, D: did you have any fever at home (.)



Picture N – time: 05:41:10
l. 52, P: yeah just f I sat and

In standard cases, healthcare practitioners rely on material equipment when measuring medical values. Indeed a thermometer is, in principle, more precise than a wrist, but this doctor uses a less precise, yet less time-consuming approach as he uses the temperature of

his own body to gauge the temperature of the patient's body. By so doing, he avoids wasting time to get hold of a thermometer, just so he can continue the flow of interaction without interruptions. The doctor's behaviour indicates an efficient prioritisation of the relevance and function of medical nested tasks in relation to the overall goal. In this case, it seems important at first to state whether the patient has a fever or not. However, immediately after this activity, the doctor needs to listen to the patient's lungs, which involves the use of his stethoscope. During this task, he starts thinking aloud and he rephrases the medical puzzle related to the patient's low pulse rate, in a way that leads to valuable results.

6.2.2 Think-aloud strategies: verbal utterances as material anchors

A final example of how best practice involves activities that are not accounted for in protocols and guidelines relates to how a think-aloud strategy and overt cognitive puzzling can lead to valuable insights in task accomplishment. In particular, the following excerpt involves a situation where the same doctor from the situation before listens to the patient's lungs when the electronic equipment above the patient's head starts beeping. Apparently the beeping alerts the medical team about the patient's pulse rate that has been low during the whole episode, and even in the ambulance. The reason for the low pulse is unknown at present, but as the doctor uses a think-aloud-approach he solves this problem.

It is hypothesised that thinking aloud when challenges and problems emerge, increases the chances for problem-solving due to the transitory structural and quasi-stabilising qualities of verbal articulation. Compared to abstract reasoning (Clark, 2008), verbal articulation has a local materiality that increases the ability for cognitive manipulation, as utterances are activities, and activities change the world. To support this hypothesis I draw on Hutchins' (2005) idea of material anchors, Kirsh and Maglio's (1994) notion of epistemic actions and Clark's (2008) notion of linguaform thinking.

Hutchins defines material anchors in relation to external cues such as annotations and material artefacts: "I call an input space from which material structure is projected into a blend a 'material anchor' for the blend. The term material anchor is meant to emphasize the stabilizing role of the material structure" (Hutchins, 2005:1555). I refer to thinking aloud as a strategy for creating material anchor points that facilitate complex cognitive problem-solving. Utterances are locally perceivable in interaction and as we do things with words, we change situations and perceive them in a way that can be useful for task accomplishment. Torre (2014) characterises written annotations as material anchors for future action, and Fauconnier and Turner (2002) likewise investigate verbal and written language as material anchors. Hutchins (2005) hesitates to define written and verbal language as material anchors, but the crucial point, in my view, is not to mistake words as material anchors for the concepts they represent. It is the physical act of articulating wordings that functions as a material anchor.

In a similar vein, Kirsh and Maglio (1994) describe how skilled Tetris players move a Tetrazoid before they have decided where they will place it. They describe such moves as

having an epistemic function: “These actions are not used to implement a plan […] or reaction; they are used to change the world in order to simplify the problem-solving task” (Kirsh and Maglio, 1994:513). Finally, Clark (2008) hypothesises that “in addition to the important cognitive-affective role of inner dialogue, there may also be cases in which verbal rehearsal supports a kind of perceptual restructuring via the controlled disposition of attention” (Clark, 2008:48).

In what follows, I show how a thinking-aloud strategy serves as cognitive scaffolding rather than as a communicative purpose as the doctor suddenly links a problem with a solution. This situation pivots on the cognitive benefit from thinking aloud when cognitive challenges emerge, and that much is gained by investigating what practitioners do beyond procedure-following.

Transcript 6.2
Duration: 00:41:40 seconds

DANISH ORIGINAL

Excerpt 2

94. 06:29:80, ps. (7.6) [D examines P with the stethoscope and the surveillance monitor bibs]
95. 06:37:40, D: altså selvom han har en hå han har en pu øh en puls på 46 han er altså også i (xxx)behandling som sænker hans puls
96. 06:43:30, ps. (0.4)
97. 06:43:70, D: så det er formentligt derfor
98. 06:44:70, ps. (1.8) (D listens to P’s lungs)

ENGLISH TRANSLATION

Excerpt 2

94. 06:29:80, ps. (7.6) [D examines P with the stethoscope and the surveillance monitor bibs]
95. 06:37:40, D: well even if he has a ho he has a pu eh a pulse rate at 46 he is also in (xxx) treatment right which lowers his pulse
96. 06:43:30, ps. (0.4)
97. 06:43:70, D: so that is presumably the reason why
98. 06:44:70, ps. (1.8) (D listens to P’s lungs)

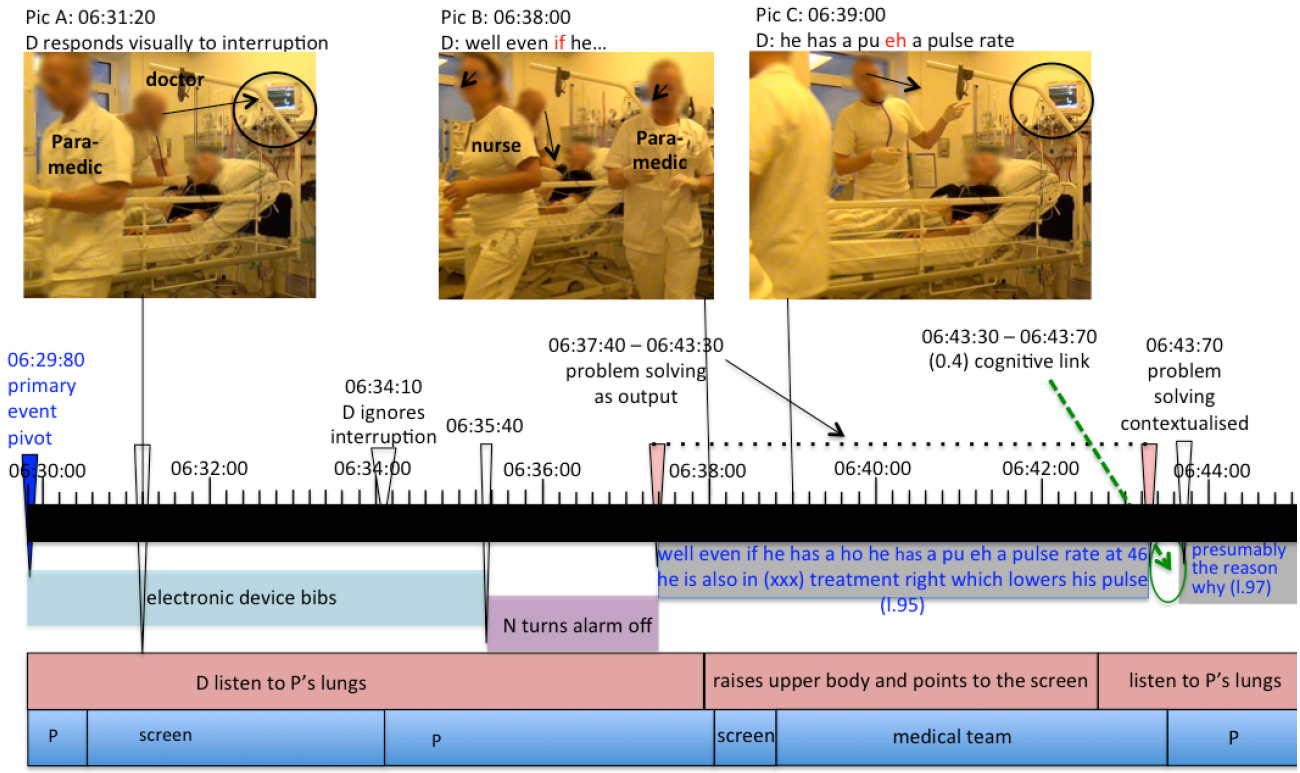


Figure 6.3: Thinking aloud as a cognitive strategy

The dark blue text indicates the doctor's vocal utterances; the pink layer indicates the doctor's actions; and the light blue layer indicates the doctor's gaze

The figure visualises how thinking aloud affords new perceptions that has consequences for how a local nested problem (the patient's low pulse rate) is understood. As the doctor initiates the examination he gazes at the patient's chest. The surveillance equipment starts to beep and it continues for 5.60 seconds. 0.8 seconds after the equipment starts beeping, the doctor responds to the interruption through gaze (see figure 6.3). The beeping serves as an event pivot and it guides the doctor's attention toward the screen, even though he continues to listen to the patient's lungs. He gazes in the direction of the screen for 3.5 seconds, perceives the values on the screen, and then gazes back at the patient's chest. The doctor contains the demanding disturbance and 5.60 seconds after the beeping started, the nurse responds to it and stops the beeping. The doctor does not switch tasks but prioritises continuing with what he is doing. However, at 06.37.40 he starts to utter: *well even if he has a ho he has a pu eh pulse rate at 46 he is also in (xxx) treatment right which lowers his pulse* (line 95). Just as he initiates this utterance, he raises his upper body, stops examining the patient and continues to talk as he gazes briefly at the screen and then towards the medical team. As he finalises his utterances he resumes the examining task. Cognitively, he interrupts his own examination task and he shifts from listening to the lungs to explicating a hypothesis before he resumes the examination. By scrutinising his utterance further, it indicates a cognitive aspect of dealing with a medical puzzle. The doctor's utterance in line 95 is different from his other utterances in many ways. It lacks coherence and clarity, as his sentences are non-grammatical and full of repair. Initially, the doctor's

utterance indicates a concern about the consequences of the low pulse rate: *well even if he has a ho he has a pu eh pulse rate at 46*, but he then ends up concluding: *he is also in (xxx) treatment right which lowers his pulse,* which takes form as an explanation. As the doctor utters: *(xxx) treatment*, a natural subsequent elaboration is the side effects of such treatment – and in this case the side effect appears to be in line with the problem: the low pulse rate. The doctor seems unaware that he has solved the problem and he resumes the examination task. By framing the problem verbally, the doctor's utterances become overt and transitory material anchors that scaffold cognitive understanding. Thus, as his utterances materialise in the cognitive system, they become perceivable affordances for sense-making. The 0.4 second pause is a sign of a realisation phase where the doctor experiences his insight as an insight: *so that is presumably the reason why* (line 97). As shown in figure 6.3, the problem is solved during his utterance in line 95 (06.37.40 – 06.43.30), but it is first perceived as a result or solution afterwards. Cowley (2014a) has shown this reverse order in problem-solving in an experimental study, and he underlines that solutions are perceived as solutions due to the act of perceiving verbal utterances and linking them to a specific problem or task: "*Far from speaking because he has found a solution, it is because he says [a task-relevant utterance] that he finds the solution*" (Cowley, 2014a:61).

Even though the doctor verbally articulates situated cognition, he is not communicating with the team in a traditional sense. No one responds to his utterances, and he has no eye contact with any of the team members that are occupied with other tasks. Nonetheless, he chooses an alternative to abstract reasoning: the thinking-aloud strategy. The claim is that due to the local material attributes of verbal utterances, it becomes easier to structure and alter chaotic thinking just as when intermediate results are written on a blackboard during complicated calculations. Rather than articulating hypotheses to achieve a goal (a pragmatic action), verbal articulation is perceived in action, in a way that can yield cognitive results (because of its epistemic function). Verbal utterances, thus, enable the doctor to sculpt and mould processes of valuable attention (Clark, 2008) as the chaotic wordings suddenly manifest in a perceivable order: *well even if he has a ho he has a pu eh pulse rate at 46* (line 95). Clark (2008:48) further discusses how experts to a higher degree than novices benefit from uttering 'small strings of words' and 'simple maxims' as they:

> can use them to tune and modulate highly learned forms of embodied performance […] Linguaform reason, if this is correct, is not just a tool for the novice […] Instead, it emerges as a key cognitive tool by means of which we are able to objectify, reflect upon, and hence knowingly engage with our own thoughts, trains of reasoning, and cognitive and personal characters. This positions language to act as a kind of cognitive superniche: a cognitive niche, one of whose greatest virtues is to allow us to construct [...] an open-ended sequence of new cognitive niches. (Clark, 2008:59)

Put simply, the doctor is able to engage in interactivity as he relies on expertise and the qualities of verbal articulation. Finally, this example shows exactly how language and cognition are part of the same activity and what is gained by using a think-aloud strategy in complex cognitive reasoning.

6.2.3 Embodied procedures

Overall, in this case, the doctor knows the procedures backward, which enables him to balance expectations *in situ*. Indeed, the doctor relies on procedures but he is not constrained by their inherent sequential order and he is able to perform beyond what procedures prescribe when the unexpected occurs and when it enhances performance. For instance, the doctor meshes nested tasks in the overall diagnostic process: anamnesis and physical examination. This approach saves time and enhances task efficiency and the dialogical relationship between the patient and the doctor.

The procedures emerge as an underlying function in his adaptive skilled behaviour. Gibson describes how embodied skills afford automatic behaviour: "The sailor can feel the rope and tie the knot even in darkness. […] The man with a walking stick can even feel stones, mud, or grass at the end of his stick. Yet all these perceptions come from the contact between the adjacent surfaces and the contacts of bones upon another" (Gibson, 1966:112). The doctor's historical body becomes a functional procedure-tool that empowers diagnostic processes. While the doctor integrates the patient as an important cognitive resource in the anamnesis and examination process, the risk of misunderstandings is minimised remarkably. When co-acting, the patient and the doctor jointly achieve the goal by relying just as much on touch as on verbal narratives. The doctor applies an alternative thinking-aloud strategy that makes possible cognitive work that yields results due to its quasi-material quality. Finally, we observe how medical decision-making is a synthesis of understanding the patient's narrative through whole-bodied interaction and relying on experience to the extend the procedures prove functional in the situation. This analysis is a counterexample of human error cycles. Yet such examples are important for the understanding of how error cycles can be anticipated. While it shows the negative feedback mechanisms that characterise best practice, it helps identifying absence of such mechanisms in situations where practitioners follow protocol but, because they do so, struggle to adapt flexibly to changes in the situation.

These insights open for alternative approaches to be applied in education programmes, which eventually can shape sociocultural dynamics and lead to a more dialogical and less error-prone practice. The importance of gestures, procedure biases and cognitive strategies could profitably be discussed in the preparation of educational programmes. Thus, if doctors are not fully versed in the procedures, following them requires a lot of cognitive effort as the following case shows. The procedures become so important that more cognitive power is allocated to the process of following them than to critically rely on them.

6.3 Case II: procedure following: cognitive complexity and simplicity

This case presents common obstacles related to novices' use of procedures in emergency medicine. The case shows how a novice male doctor is constrained by multiple, diverging expectations during history taking. As he relies on procedures his focus is on getting sufficient information that he can document in the electronic medical record at a later

stage.

The case involves an elderly female patient with no previous medical history. She woke up the same morning feeling unwell. She went to see her GP who referred her to the hospital as he detected some irregularities in her EKG. In the meantime the woman's condition has improved and as she arrives at the ward her medical condition is normalised and no symptoms are immediately detected as she is introduced to the doctor. However, she is nevertheless shaken by the heart conditions she experienced earlier. Below is an illustration of the layout.

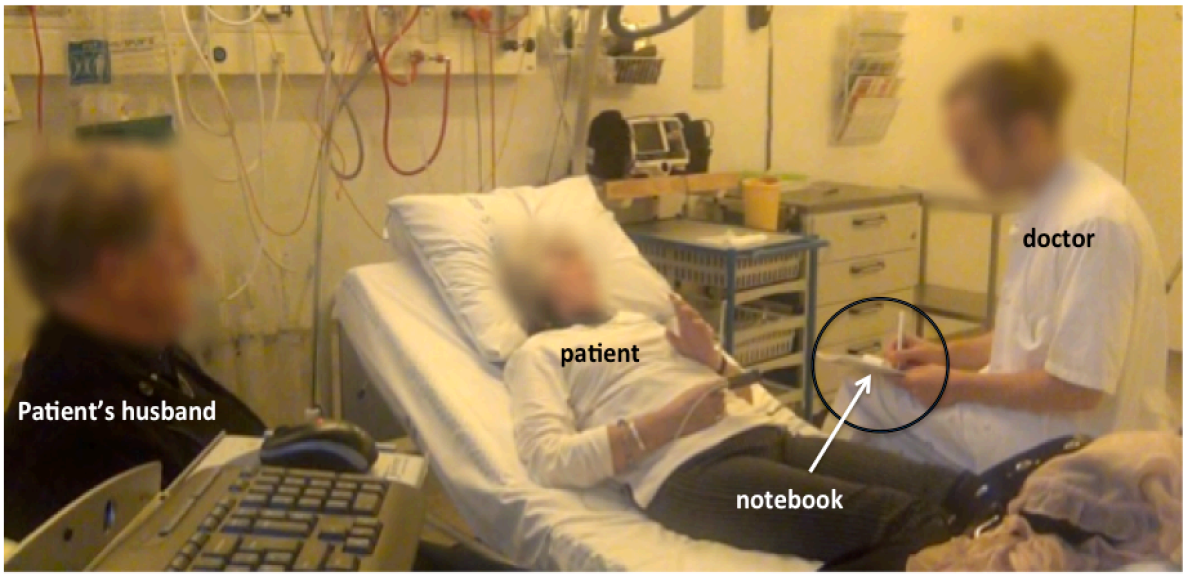


Figure 6.4: Overview of the layout: anamnesis

6.3.1 The use of notebooks in anamnesis: managing the complexity of writing and interacting at the same time

The doctor has been working at the department for only a week or two at the time the recordings took place. A crucial work procedure involves documentation of specific information in the electronic medical record after anamnesis and physical examination. All relevant information need to be documented so other healthcare instances can check and follow up upon what has been done and decided by whom. Thus, to structure and ensure detailed memory, novice doctors often use notebooks.

As we enter the conversation, the novice doctor has just initiated the anamnesis to determine what has caused the patient's condition and he has just asked her the broad question: *what has happened?* The patient begins her narrative by referring to two conversations she has had with her husband and GP respectively:[23]

[23] An invariant communicative pattern is registered. Variations of *and, and then, then* utterances (yellow) are responded to with variations of minimal responses as *okay, no, yes, mm* (green). This pattern is discussed in the analysis.

Transcript 6.3
Duration: 00:48:90 minutes

DANISH ORIGINAL

1. 00:02:00, P: Jeg synes jeg har ondt i hjertet siger jeg så til ham [GP]
2. 00:04:20, D: okay
3. 00:04:80, P: så siger han (.) nå men det var jo ikke så godt vel
4. 00:07:00, D: nej
5. 00:07:30, P: og så øh (.) så slog vi det lidt hen (.) men så synes jeg at jeg har haft det nogen gange siden
6. 00:13:50, D: okay
7. 00:14:20, P: Og så tænker jeg (.) er det så fordi det gør ondt (.) eller er det fordi man er fokuseret på det eller hvad er det for noget
8. 00:20:00, D: ja
9. 00:20:10, P: og det vil så fordi min mor hun havde dårligt hjerte
10. 00:23:00, D: ja
11. 00:23:60, P: og min far han er død af en blodprop
12. 00:25:60, D: okay
13. 00:26:00, P: og så så så tænkte jeg [pl
14. 00:27:40, D: [er din mor død os?
15. 00:28:50, P: ja ja
16. 00:29:30, D: ja
17. 00:29:50, P: men det er mange år siden
18. 00:30:40, D: ja
19. 00:31:40, P: og så øhm (.) men så i går så siger jeg til [husband's name] det gør altså ondt (.)
20. 00:36:80, D: mm
21. 00:37:40, P: så var vi blevet enige om at jeg skulle gå op hos lægen i dag
22. 00:40:20, D: ja
23. 00:41:50, P: og så (.) øhm blev der taget sådan et (.) kordiogram eller hvad det hedder
24. 00:46:20, D: ja
25. 00:46:80, P: og så øhm var der sådan noget han sagde der var forkert i det
26. 00:50:40, D: okay

ENGLISH TRANSLATION

1. 00:02:00, P: I think that I have some pains in my heart I then tell him [GP]
2. 00:04:20, D: okay
3. 00:04:80, P: then he says (.) well that is not a good thing, right
4. 00:07:00, D: no
5. 00:07:30, P: and then eh (.) then we shrugged it off (.) but then I think I have had it a couple of times since then
6. 00:13:50, D: okay
7. 00:14:20, P: and then I start thinking (.) is it because it does hurt (.) or is it because one becomes too focused on it or what is it
8. 00:20:00, D: yes
9. 00:20:10, P: and that will then because my mother she had a heart condition
10. 00:23:00, D: yes
11. 00:23:60, P: and my father died of a blood clot

```
12. 00:25:60, D:   okay
13. 00:26:00, P:   and then then then I thought [pl
14. 00:27:40, D:                                   [is your mother dead as well
15. 00:28:50, P:   yes yes
16. 00:29:30, D:   yes
17. 00:29:50, P:   but that is several years ago
18. 00:30:40, D:   yes
19. 00:31:40, P:   and then eh (.) but then yesterday I tell [husband's name] it
                   does really hurt (.)
20. 00:36:80, D:   mm
21. 00:37:40, P:   then we did agree on that I should see my GP today
22. 00:40:20, D:   yes
23. 00:41:50, P:               and then (.) eh he did a kind of a (.) cordiogram
                   or what you call it
24. 00:46:20, D:   yes
25. 00:46:80, P:   and then eh there was something he said was wrong in it
26. 00:50:40, D:   okay
```

The local goal is to get sufficient information from the patient in order to compare the narrative with medical measurements, which finally leads to successful diagnosis and a plan for further treatment. The task is history taking and the starting point is the patient who has arrived due to previously experienced chest pain. The task is constrained by the doctor's dual orientation to the material artefact (the notebook) and the patient.

During this 48.9 seconds long excerpt, the novice doctor uses pen and paper to document every detail of the conversation as he gets hold of the narrative. His visual attention is on the documentation activity, and in total, he gazes in the notebook for 27 seconds.

Apart from line 1, 8 and 10, all the patient's utterances start with a variation of *and, then* or *and then.* The doctor confirms with continuers (*yes, no, okay* and *mm*) as co-constitutive devices in the interaction (Hutchby and Wooffitt, 2011). By so doing, the doctor treats all information as factual, equally important and this prompts the patient to continue her narrative. As a result of this structural organisation, the patient provides the doctor with subjective descriptions of what she finds relevant to bring into the anamnesis process. The doctor's minimal responses, invariance in voice dynamics, his gazing into the notebook and his primary attention to the writing task, altogether, leaves the patient with no ability to judge how her utterances are interpreted and whether they are sanctioned or not. To keep the dialogue ongoing, the patient continues to elaborate the narrative by interactively adding new information: *and then.* Furthermore, she constantly seeks eye contact with the doctor who only gazes at her when he is not documenting.

According to Goffman, (1983:5) a "game's rules" determine a set of roles and unequal rights that afford a certain distribution of turn-taking sequences (Goffman, 1983:6). Specifically, this can be investigated in the pattern of question-answer distributions. A question is seen as a powerful device where the questioner possesses the powerful role in interaction (Goffman, 1983). Ample research on doctor-patient interaction, has investigated the question-answer distribution as the key mechanism to constitute power asymmetries (Fairclough, 1992; Liddicoat, 2011; Goffman, 1983). For example, Fairclough (1992) underlines how doctors direct the interaction by engaging in a three-part

cycle, where a doctor is the one to decide the initial question, that the patient needs to respond to, and to which the doctor utters a specific acknowledgement (Fairclough, 1992:149). However, in this case, the three-part cycle is not completed by new questions. The doctor uses minimal responses, which affords the patient to continue and elaborate endlessly.

During the overall conversation, this pattern is only paused by relatively small interruptions, for instance when the doctor realises that he needs extra information. These answer-response cycles are visualised in the transcription 6.3 and it indicates the default interactivity pattern in this sequence. However an event pivot causes changes in the interaction pattern for a short moment. Prompted by particular, relevant medical information, the doctor tests a hypothesis, but with a minimum of engagement. This is illustrated below:

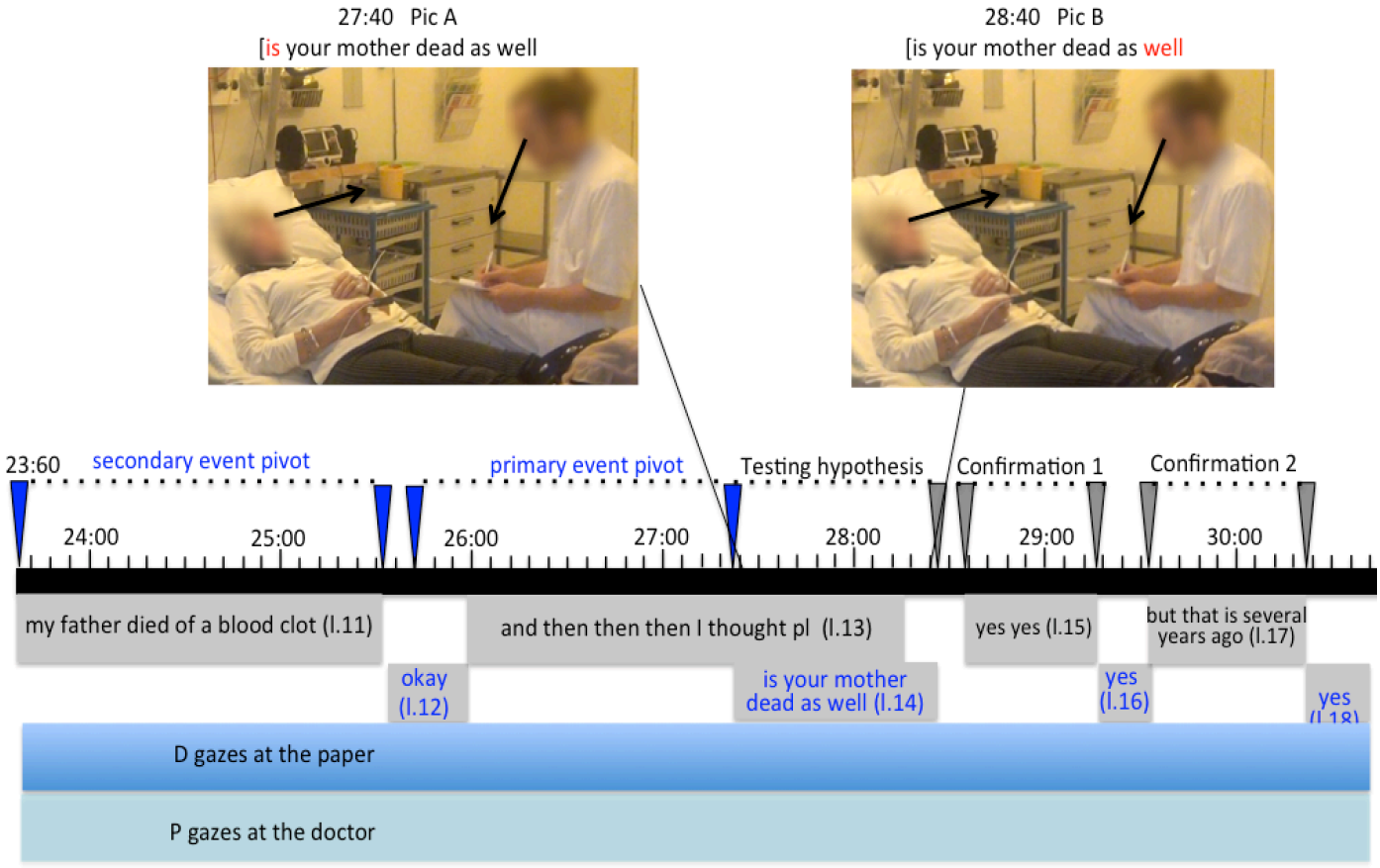


Figure 6.5: Delayed hypothesis testing

Figure 6.5 indicates the event pivots that lead to the doctor's medical hypothesis testing. As he follows protocol, he responds to relevant information, but as he is primarily concerned with documentation his interpretations are delayed which consequently affects both the emotional alliance and the interaction pattern.

While the patient tells that her mother had a heart condition (line 9) and adds that her

father died of a blood clot (line 11), she reveals medically relevant information that is potentially relevant for the diagnostic process. The information (line 11) is defined as a secondary event pivot as the doctor reacts to the information after he has documented it in the notebook. Thus, it is hypothesised that as he perceives the represented narrative in the notebook, it serves as a primary event pivot that prompts him to interrupt (line 14) 2 seconds after the patient has uttered the information. As he strictly follows procedures and documents every detail down on paper, the doctor-patient relationship is indeed constrained by the doctor's primary attention to the documentation task and it reduces sensitivity. Moreover, this reduced sensitivity shows in the doctor's interruption. The *as well* (line 14) underlines the factual aspect of the question *is your mother dead as well?* and the doctor gazes in the notebook rather than at the patient as he seeks clarification, see picture A and B in figure 6.2.

Balancing multiple tasks to achieve the overall goal increases cognitive complexity. Writing and interacting with the patient requires a strict focus on what is being said, how this is interrelated and causes relevant medical associations, and what is being represented in the notebook. Evidently, such procedures complicate another nested activity in the anamnesis task: situated sensitivity. As mentioned in the beginning of this chapter, an important aspect in the diagnostic process is to make the patient feel comfortable. In this case, the interaction is affected by the way the notebook and pen are immersed into the doctor's working body. Following Kirsh (2013), the added effort of using material artefacts affects one's perceptual array:

> Perception is altered by our skill in using tools. This is the next implication of extending the embodiment paradigm to include tools. Hills look steeper than normal to subjects wearing a heavy backpack. When a tool is absorbed into our body schema, our perception of height, distance, and related magnitudes changes. The added effort of carrying around weight affects perception. (Kirsh, 2013: 3:9)

Analogously, the doctor's use of the notebook affects his perception. First, he uses it as an aid to free cognitive power from remembering, but as the doctor-artefact cognitive system becomes centred on writing, this activity draws attention away from other elements that are important in the diagnostic process. He does not perceive the patient's embodied dynamics, and the artefact-rich interaction makes him at risk of losing overview of the narrative since he is constrained by the delay that interpretation and writing cause. To understand why the doctor is so fixated on procedure-following, the function and effect of procedures need to be compared to staff's expectations and consequences of missing relevant information. For instance, Angeli (2015) shows how a medical director, during a staff meeting at an emergency service unit, pointed out the importance of protocols and procedures because a lack of solid communication and recall entailed misunderstandings about a patient's treatment:

> The medical director brought up a PCR [patient care report] on the overhead projector and verbalized the information written on it. He said, "Based on this patient's status, he should

> have been given two IV lines and not one. The PCR states that he had one IV line, which could have caused many complications for the patient. This treatment doesn't follow protocol." A paramedic sitting across from me raised his hand: "That was my patient. I started two IV lines following protocol." The medical director responded, "Well, you didn't write it down, so you didn't do it. We have to get better a documenting our work, folks. Patients' lives depend on it." (Angeli, 2015:34)

As the doctor lacks embodied experience with procedures and how this work practice emerges, he relies on rules and medical protocols for proper behaviour – and he does so by the book. However, healthcare professionals have mentioned that knowing how to act efficiently and smoothly comes from experience (Angeli, 2015).

While material aids enable comprehensive documentation at a future point, they also inhibit the dialogical flow of anamnesis due to the complexity that follows in managing verbal interaction *and* writing as well as a focus on which procedures follow next. The act of writing itself requires cognitive power and time that delays his situational sensitivity. He cannot pay equal attention to two cognitively different tasks at the same time. By maintaining an action hierarchy, the doctor prioritises the documentation activity, which reduces the chances for negative feedback mechanisms in interactivity. The doctor shows no signs of frustration and he does not take control of the anamnesis process, which exacerbates the process. The patient's continually varied use of *and then* establishes an interactivity trajectory where the doctor continues to document the patient's narrative and he continues to be a step behind in the process.

As the local outcome is functional and acceptable according to medical standards, the doctor gets medical information by a circuitous route and he uses multiple cognitive resources and time on the anamnesis task. The amount of resources spent means less resources to other diagnosis situations at the ward. As resources already are low, priorities are crucial for maintaining a good work and patient flow in the ward. However, when left alone and unaware of the positive feedback mechanisms in interactivity, potential error cycles are only perceived by the observer and momentarily by patients. In such situations, becoming an expert depends solely on repetition that *eventually* releases cognitive power to accomplish other tasks and adapt to situational changes.

6.4 Conclusion: understanding the status and function of procedures and expertise

Angeli (2015) argues that professional memory, which is distilled in textbooks, protocols and other procedural guidelines have "to structure a response, but it needs to be flexible enough to account for all types of unpredicted situations. In short, protocols need to prepare […] EMS professionals to care for a patient but allow them freedom to adapt the protocol according to the patient's needs" (Angeli, 2015:31). In this work, inflexibility appears to be the main problem with the working procedures and inexperience shows as a challenge in relation to how procedures are managed *in situ*.

Procedures are important, necessary and useful and they must be followed to sustain the organisation (Angeli, 2015). Understanding the invariant nature of task performance is

crucial to adapt procedures successfully and for future coordination to be managed effectively. The problem with procedures, thus, is not a question of their raison d'être, rather it is related to the status and understanding of the procedures' function in the ward. First, procedures work like models for proper behaviour and they have been developed with a focus on what to ask in a sequential order. The procedures are formed with a written language bias as interaction tasks are described as static, autonomous and structure-like information steps in treatment (Linell, 2005). Second - and related to the written-language-bias - the procedures do not embrace the qualities of whole-bodied coaction. As focus is on what to say (and only what to do in relation to physical examination), the interpersonal relationship and the dialogue between healthcare practitioner and the patient are reduced to information exchange sequences. However, as the first case shows, functional task performance can be accomplished efficiently when the healthcare practitioner meshes procedures and relies on inter-bodily dynamics in task performance. When protocols have built in a step-by-step procedure with specific questions to ask in a specific logical order, flexible adaptive behaviour is difficult to manage without violating procedures. Education programmes could benefit from the insight that procedures are in themselves neither good nor bad. Their functionality depends on how they are managed. The management of procedures in situated interaction depends on the practitioner's level of expertise and experience, which again equips the practitioner with the ability to adapt flexibly and maintain an overview of the situation. Such flexibility is exemplified in the first case, where the expert creatively develops alternative strategies: (*a*) he meshes tasks, (*b*) he relies on inter-bodily dynamics in coaction and (*c*) he uses a thinking-aloud strategy that materialises as material anchor points that become affordances for sense-making.

In this analysis, procedures prove functional for the cognitive system when the expert applies them to expand the perceptual system. The expert is able to embody the procedures and avoid getting overwhelmed as he moulds them creatively to fit situations where the unexpected occurs. To the novice doctor, procedures are functional as their guiding action steps *afford certain decisions* of how and what to do, but to the cognitive system in general, they are dysfunctional as they entail reduced sensitivity. Moreover, procedures prompt the novices to rely on artefacts in order to scaffold and enhance memory. By documenting the anamnesis in a notebook, the practitioner is capable of following protocols *in situ* and at a future point. Knowing that procedures can be followed during the whole process is a way of avoiding being overwhelmed.

The suggestion of 'procedure ambiguity' supports the hypothesis that novices in general adopt and follow explicit standard procedures and guidelines in a rigid way. Experienced practitioners rely on embodied expertise and situational features that equip them with an anticipatory understanding of which procedures and tools are useful, and most importantly, which procedures and tools constrain decision-making and thus afford dysfunctional results. This is important to understand how error cycles are anticipated or not, as practitioners disobey or follow the organisation's logic to achieve the overall successful output: optimum treatment for the patient. Indeed, it is a balance to know when the exclusion of aiding tools leads to more dialogical behaviour and a richer layout of

affordance environment, or alternatively leads to stress and cognitive and interpersonal overload.

7. Interruptions and multi-task tolerance in emergency medicine

7.1 Interruptions and values realisation in emergency medicine

Coding revealed that interruptions appear regularly during task performance (see table 4.1). Interruptions count as any situation where a practitioner is required to change his or her orientation to the interrupting source, either briefly or for a longer period of time. Thus, sometimes the interruption leads to a task-switch before resuming the original task; at other times they just cause a few moments of pause before the practitioner resumes the work. In my data, several kinds of interruptions occurred during diagnostic processes and pre-treatment. Overall, two types of interruption patterns emerged. On the one hand, the more responsibility and expertise a practitioner has, the more frequently he or she is interrupted for advice, permissions and overview reports. Thus, primary doctors[24] were frequently interrupted. As part of their job, they need to maintain the overview of the patient flow at the ward, and they need to facilitate the junior doctors when hard decisions need to be made. Consequently, they spend considerable time and effort to get back into the workflow. On the other hand, the less experienced a practitioner is, the more frequently he or she is interrupted for clarifications and misunderstandings. The latter is often more easily distracted than the former. When comparing doctors and nurses, the nurses are the less interrupted group in the dataset.

Based on coding I enlist a heuristics of interruption types. However, this list is not a

[24] The primary doctors are the most experienced doctors in the ward. They serve as flow masters and team coordinators as they delegate assignments to the medical teams and manage the patient flow. They also supervise the junior doctors in medical and clinical issues. This primarily happens backstage (Goffman, 1959) in a coordination room, but sometimes a situation requires the primary doctor to check up on the patient to supervise the novice doctor. When needed the primary doctor visits patients, and he is always present from the beginning in highly acute situations. The primary doctor refers directly to the physician on call.

suggestion of a general interruption typology or taxonomy, but a list of the interruptions identified within this dataset. Thus, the practitioners were interrupted by (*a*) phones to which they are required to respond immediately, (*b*) other local team members that need information to get on with their individual tasks and procedures,[25] (*c*) colleagues outside the local team that enter the room and interrupt for various reasons, for instance with questions regarding other patients that practitioner has been involved with (at other times they need advice, status reports etc.), (*d*) the patient or his relatives that ask for elaboration for instance on previously given information that leads to task switch, and (*e*) alarms and other electronic surveillance equipment or monitoring displays that disturb current workflow. The most frequent and distracting interruption types identified in the dataset are phone interruptions. Further, the nature of phone interruptions is distinctive: their complete lack of timing compared to verbal interruptions for instance and their demand of immediate response is distinctly palpable.

Several studies on interruptions in emergency medicine conclude that (*a*) the number and frequency of interruptions are staggering and should lead to serious concerns about intervention strategies amongst healthcare educators and providers (Chrisholm et al., 2001; 2002; Clark, 2011), (*b*) that interruptions often lead to task-switch or cause practitioners to leave tasks unfinished (Clark, 2011), (*c*) that interruptions have a negative impact on patient satisfaction (Jeanmonod et al., 2010), (*d*) that interruptions often disrupt working memory (Cioera et al., 2002), and finally, (*e*) that interruptions predispose healthcare practitioners to making human errors (Clark, 2011).

Chrisholm et al., (2001) label emergency practitioners as 'interrupt-driven' and underline that even though we have extensive knowledge about interruptions from other fields – e.g. aviation – we have not yet gained a comprehensive understanding of interruptions in the emergency ward (2002). Though the amount of studies within this field has increased, the studies primarily provide evidence of the amount of interruptions faced in healthcare emergency settings (Berg et al., 2013). At best, in such cases, the consequences of interruptions are elaborated in relation to specific outcomes. While such insights are important, these studies lack qualitative investigations of how interruptions emerge and are countered in situated interaction. Thus, whether such studies cover the amount of interruptions, how interruptions are distributed across various departments (Chrisholm et al., 2001), or what kind of tasks or which groups are interrupted most frequently, the studies lack an understanding of the particular interactive dynamics before, during and after interruptions occur. Advancing the understanding of interruption cycles depends on investigations of how a cognitive system deals with disturbances rather than assuming interruptions are something that is being imposed on the individual.

By turning to how individuals attend to typical interruptions, the most common intervention programmes point to implementation of electronic coordinating tools, general team training and more education about what interruptions can do to working memory of

[25] This kind of interruption is often more *timed* as the local team members know what and when they interrupt contrary to when a colleague interrupts by calling on the phone.

the individual. For instance, recent studies have investigated interruption resumption amongst nurses in intensive care units (Rajkomar and Blandford, 2012b; Grundgeiger et al. 2010). They show how nurses keep track of which step of a task remains or is to be completed by employing artefacts as reminders (Rajkomar and Blandford, 2012b). While these studies focus on how nurses distribute the cognitive task in space as they rely on material artefacts as useful cognitive anchor points, they maintain an understanding of interruptions as local cognitive obstacles. Interruptions unquestionably have a negative effect on outcomes. However, studies need to expand the scope to investigations of the cultural dimension of interruptions. Why, in some situations, are given interruptions rather harmless, when, in other cases they eventually lead to human error? According to the ecological perspective on human error, it is not an interruption in itself that causes human error, it is interactivity in which interruptions are embedded that guides what happens. Thus, while conventional observational studies (including studies with retrospective interviews) tend to focus on medical tasks and content, a richer understanding is gained by scrutinising how a cognitive system draws on interactivity (Steffensen, 2013), and situational and cultural affordances for actions (Pedersen, 2010).

To explain how interactivity, including cultural and material affordances for action, leads to different outcomes in different contexts, Hodges and Baron's theory of values realisation is applied on two different cases. As mentioned in chapter 3.4.2, Hodges and Baron provide an ecological account of values that propose thinking in terms of a value heterarchy (Hodges and Baron, 1992). It is argued that this theoretical concept can illuminate how cognitive systems make sense and deal with interruptions in situated interaction characterised by multiple diverging constraints on action. A few comments on the theory are added prior to the analysis.

With Gibson and Crook (1938) Hodges argues that task performance "is a skill of perceiving and acting within a *field*" (Hodges, 2007a:154). A field is defined as a continuously changing set of potential pathways. With the example of driving Gibson and Crook emphasise how the field of safe travel constitutes an ecosystem defined by values. Safety is an important one (Hodges, 2007a), but as other values also constitute the ecosystem, the field is constrained by multiple values. Thus, as an ecosystem, driving for instance is at the same time bounded and dynamical. Physical laws and social rules are, according to Hodges, constraints that serve as resources for performing a task, but Hodges defines the actual task as: "a moral task that requires steering a vehicle through a cluttered environment safely and accurately. The use of the term moral in this context means motivated by goods (i.e., values), including those that are epistemic (e.g., accuracy) and ethical (e.g., justice)" (Hodges, 2007a:155). Thus, driving is defined by multiple constraining values, for instance safety, efficiency and tolerance (Hodges, 2007a). Hodges presents a radical claim about the obligatory status of values:

> Thus far, I have claimed that the physical field identified by Gibson and Crooks (1938) is an ontologically real dynamic (i.e., it is continuously evolving) that is defined by its potentials for realizing values. Because values define the field, they are obligatory. Driving, as such, cannot exist unless values such as safety, accuracy, tolerance, comprehensiveness, and efficiency are

> properly acknowledged in the recruitment of physical laws and the construction and use of social rules. Driving became possible for humans when they discovered enough about physical laws to organize them comprehensively enough to build vehicles. As soon as the number of vehicles increased enough for collisions to happen, social constraints were added to the physical constraints. However, the motivation for engaging in physics and engineering, as well as the development of regulations about how vehicles could be constructed and used, emerged from moral obligations to realize values. The development of goals (e.g., building an automobile) and the development of rules (e.g., supervising a traffic system) are motivated by and answer to the ecosystem and the values that provide its constitutive standards." (Hodges, 2007a:156)

Hodges argues that recent studies on driving, for instance, tend to isolate single values when considering how the task is accomplished and this reduced view leads to incomplete and faulty conclusions about what happens in driving. In a similar vein, Dunbar and Garud have investigated how the inability to balance two different assessment criteria (safety and a concern for meeting schedules) caused the Columbia Shuttle Flight STS-107 to disintegrate (Dunbar and Garud, 2007). Dunbar and Garud argue that the majority of studies of the Columbia Flight disaster have built their interpretations on a traditional conceptualisation of organisations as information-processing systems "that are somehow subject to the objective control and direction of responsible individual decision makers" (Dunbar and Garud, 2007:417). Thus, when systems break down, individuals are blamed for irresponsible and inattentive behaviour (cf. chapter 1). Dunbar and Garud propose to think in terms of distributed knowledge to underline that a single individual "cannot know all of the relevant information that it requires to categorise an event in real time and, consequently, investigations will be forced to consider a wider range of explanatory factors" (Dunbar and Garud, 2007:417). By combining Dunbar and Garud's proposal of distributed knowledge with Hodges values heterarchy, the following two cases are investigated as diagnostic fields - or systems - with a cognitive agenda constrained by multiple values. When interruptions occur, the system needs to adapt to the changes without violating its boundary conditions by balancing the field's constitutive values. One way of balancing the values is by relying on distributed resources and managing nested tasks through joint coordination, as the case examples show.

Specifically, this chapter investigates the overall cognitive systems in which interruptions emerge. Interruptions are inevitable in the ward but they are not anticipated and managed in the same way amongst practitioners. As interruptions are local demands for immediate action that stress and disturb real-time cognition, it is hypothesised that practitioners prioritise interruptions over the on-going task (often dialogue with the patient) to reduce the immediate stress and pressure. If an interruption is not responded to, it often continues to demand a response (incoming phone calls, electronic alarms etc.), and few people can cope with such pressure even though they are occupied with other important tasks. Consequently, a fixed task hierarchy dominates interruption management and local interaction is at risk of breaking down. The hypothesis was investigated in two cases. The first case shows how a novice doctor handles information coming from multiple sources: (*a*) the patient, (*b*) a team member and (*c*) a colleague on the phone. He is interrupted

several times during a 54 seconds sequence where he tries to get hold of the patient's narrative. Multiple expectations – inherent in the organisational system of which he is part – prompt him to move in and out of different modes of interaction. He becomes overloaded and prioritises some expectations over others. The second case shows how a medical team successfully handles a telephone interruption during history taking. While an interruption always affects the flow of interactivity, it does not necessarily have to be a significant or problematic disturbance that violates the boundaries of the cognitive system. By exploiting the qualities of team collaboration this example shows how an interruption is managed functionally through highly coordinated team performance initiated by an experienced nurse.

7.2 Case I: treating interruptions as what?

This example emphasises how challenging it can be for doctors to act dialogically and in a caring manner for the patient in an interruption-driven workplace. Repeated interruptions increase the level of complexity, stress and cognitive effort in otherwise simple tasks. The focus is on how a young novice doctor acts to satisfy multiple demands of attention simultaneously in a rather critical situation.

At the moment we enter the conversation, the patient, an elderly woman, has just arrived by way of a 911 call. Earlier the same day she felt dizzy and she suddenly fainted some moments after she went to the lavatory where she had lost a large amount of blood. The patient now updates the novice doctor about her concerns and thoughts up until the moment she fainted. Below is an illustration of the situation.

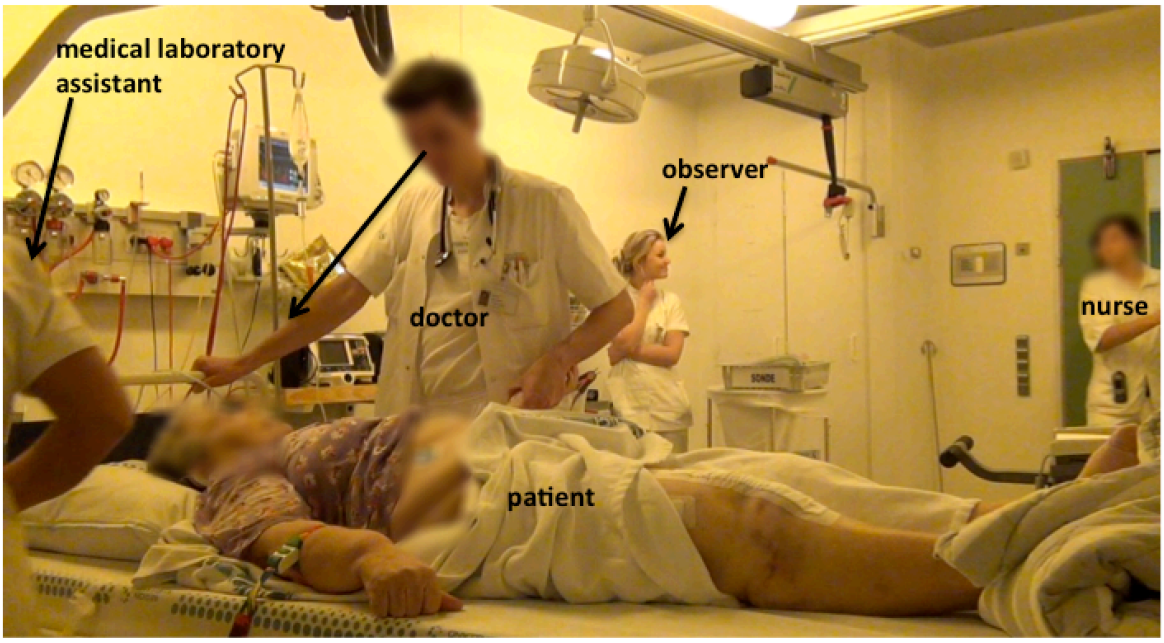


Figure 7.1: Overview of the layout: an interruption-driven practice

7.2.1 Low multi-task tolerance

In this 54 seconds excerpt below, seven interruptions occur. First, attention is paid to each of these interruptions. Second, it is investigated in detail what the interruptions do to the dynamics in the cognitive system as a whole.

Transcript 7.1[26]

Duration: 00:54:00 minutes

DANISH ORIGINAL

1. 01:06:30, P: så blev jeg jo bange for jeg var alene hjemme ik (nurse enters)
2. 01:08:40, D: ja
3. 01:09:10, ps. (0,5)
4. 01:09:60, P: og så ringede jeg til (xxx) og de var ikke hjemme og så ringede jeg til [xxx] og de var heller ikke hjemme=
5. 01:13:00, D: =tak
6. 01:13:40, ps. (1.1)
7. 01:14,50, P: og vagtlægen havde lukket og det det hele [det (.) ramlede for mig (.)så tænkte jeg om jeg skulle ringe til 112
8. 01:16:80, D: [NÅ
9. 01:20:60, ps. (0.6)
10. 01:21:20, P: s så slemt var det heller ikke vel
11. 01:23:10, ps. (2.1)
12. 01:25.20, D: nej=
13. 01:25:90, P: =men så [her (xxx[x) jeg tror fredag, så skulle jeg på toilettet i[k
14. 01:26:40, N: [var der en (xxx) på hende derovre
15. 01:27:70, Ph [ring ring=
16. 01:32:00, Ph [ring ri[ng
17. 01:32:30, D: [ja
18. 01:33:50, P: og så måtte jeg jo kalde på min datter som siger mor det er ikke (.) det er ikke [(xxx) det er blod=
19. 01:36:40, Ph [ring ring
20. 01:37:00, D: =det er blod [jeg skal lige tage den her (D talks on the phone for 15,8 seconds)
21. 01:38:40, P: [(xxx)
22. 01:56:00, D: er det okay (.) jeg li:ge går u:d o:g giver en besked
23. 01:57:60, N: ja selvfølgelig
24. 01:58:30, D: ja (D leaves the room)

ENGLISH TRANSLATION

1. 01:06:30, P: then I got scared because I was home alone right (nurse enters)
2. 01:08:40, D: yes
3. 01:09:10, ps. (0,5)

[26] Interruptions are marked in red. *Ph* is an abbreviation for phone.

4. 01:09:60, P: and then I called (xxx) and they were not home and then I called (xxx) and they were not home either=
5. 01:12:80, D: =thanks
6. 01:13:40, ps. (1.1)
7. 01:14,50, P: and the duty doctor was closed and and [it all (.) fell apart (.) so I thought about calling 911
8. 01:16:80, D: [OH
9. 01:20:60, ps. (0.6)
10. 01:21:20, P: i- it was not so bad anyway right
11. 01:23:10, ps. (2.1)
12. 01:25.20, D: no=
13. 01:25:90, P: =but then [this (xxx[x) Friday I think then I had to go to the toilet ri[ght

14. 01:26:40, N: [did we have a (xxx) on her over there
15. 01:27:70, Ph [ring ring=
16. 01:32:00, Ph [ring ri[ng
17. 01:32:50, D: [yes
18. 01:33:50, P: and then I had to call my daugther who says to me mum this is not (.) this is not [(xxx) it is blood=
19. 01:36:40, Ph [ring ring
20. 01:37:00, D: =it is blood [I have to answer this one (D talks on the phone for 15,8 seconds)
21. 01:38:40, P: [(xxx)
22. 01:56:00, D: is it okay (.) if I ju:st lea:ve a:nd give a message
23. 01:57:60, N: yes of course
24. 01:58:30, D: yes (D leaves the room)

During the initial part of the anamnesis seven interruptions are detected. The doctor is interrupted five times: twice by the nurse, and three times by the phone. Further, the nurse interrupts both doctor and patient, and finally, the doctor interrupts the patient. In figure 7.2 below, each interruption is highlighted and the precise timing of the interruptions is marked in relation to the cognitive undertaking. The doctor's gaze, pace, and the interlocutors' verbal utterances are analysed in relation to the interruptions. Finally the relationship between the interruption, the task being performed and the interaction type is discussed in relation to the communicative and cognitive consequences interruptions can have on the general flow of interactivity.

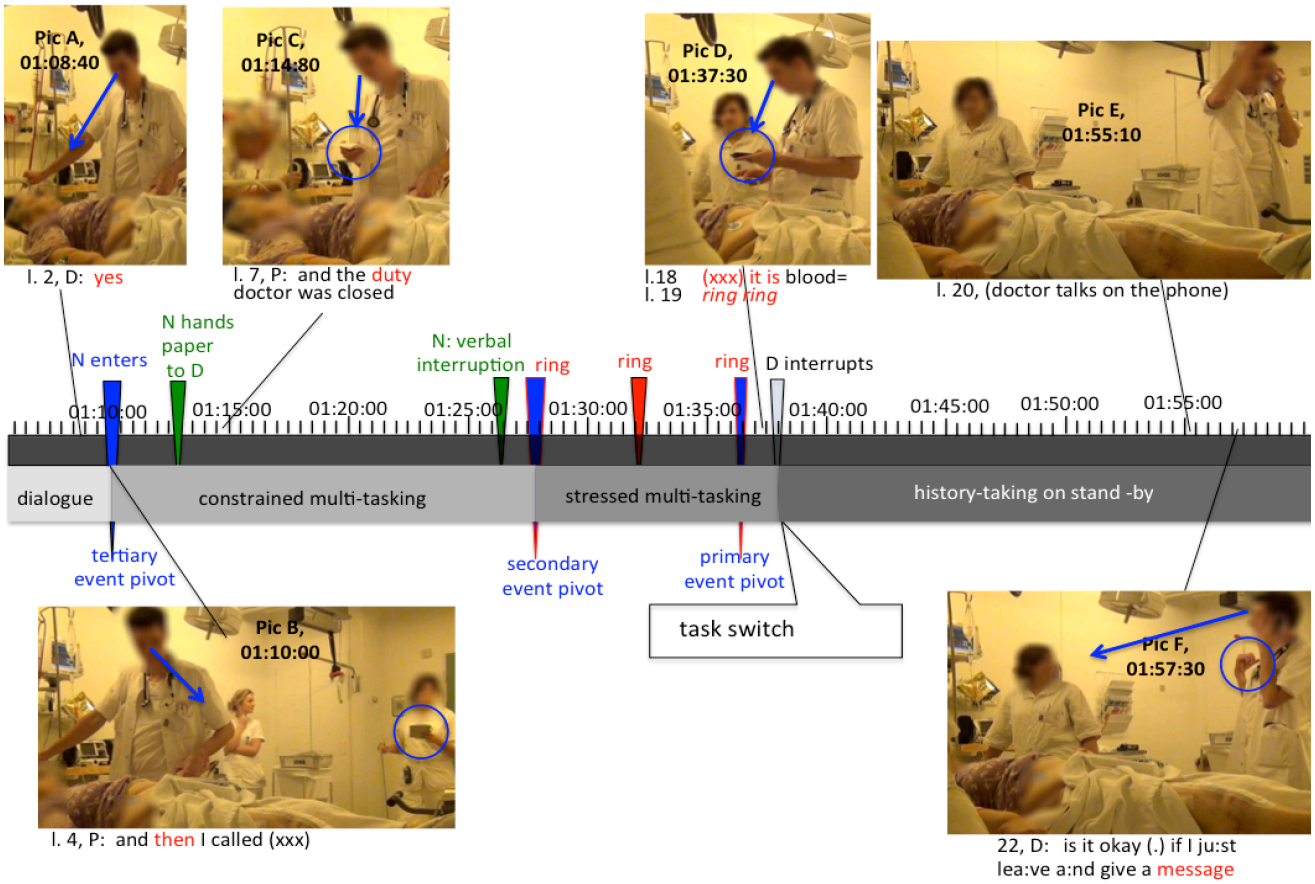


Figure 7.2: Interruptions' affect on cognitive task performance

The green triangles indicate nurse interruptions; the red indicates phone interruptions; and the grey indicates doctor interruptions. Red markings in the text indicate the verbal utterance articulated as the picture is taken. The blue triangles are event pivots in the trajectory

The figure shows how interruptions permeate and disturb simple task performance. Practitioners have constrained conditions for dialogical diagnostic task performances, as sensitive interaction requires a high, multi-task tolerance in a stressful and unpredictable environment. Most importantly it shows the feedback mechanisms *in the process* and how the stress level in interaction increases in line with the number of interruptions. The figure finally indicates how the enabling conditions for task performance are constrained and lead to task-switch.

In the following, each interruption is elaborated and discussed in relation to the context in which it appears. The analyses focus on how multiple values are balanced. An interruption requires that the (members of a) medical team live(s) up to multiple expectations at the same time.

This doctor is engaged in history taking. He and the patient constitute a cognitive system that is defined by the task and their interpersonal relationship. There is an implicit agreement that to solve this task, they need to coordinate and establish a trustful relationship. Hodges argues that: "coordination among humans involves two or more intentional agents synchronizing their activities; cooperation requires their working

together to achieve a common goal. It is the thesis […] that caring is the larger context that makes social cooperation and coordination possible" (Hodges, 2007a:154). Thus, as a human socio-cognitive system, caring and understanding are intrinsic dynamical and moral constraints (Hodges, 2007a). When interaction breaks down, the moral relationship between people is violated. This violation has to do with lack of coordination, cooperation and caring:

> Learning to talk with each other […] is a way of caring for others, for our self, and for the world. In the context of that caring, all these other functions of language do occur—coordination, cooperation, conformity, truth-telling, and so forth. Ecologically, we might think of talking with each other as a form of wayfinding. (Hodges, 2007a:174)

Thus, in such tasks, a cognitive system must be constituted by values as caring and trust, dialogical principles as for instance the interdependency of others in dialogue (Linell, 2009:11), and finally professional engagement to be able to pursue the cognitive agenda. Such moral obligations are obligatory for the system to uphold its boundaries. The doctor is under pressure as demands and expectations coming from outside the cognitive system conflict with activities within the system. A dilemma emerges and forces the doctor to make decisions.

To begin with, the doctor engages in dialogue with the patient. She provides him with information about what happened as she discovered her rectal bleeding at home. At the beginning, the two have eye contact and the doctor leans towards the patient and holds on to the bed headboard (see picture A). At 01:08:40, the nurse enters the room. She carries a medical sheet in her hand and she approaches the doctor. An event pivot indicates the moment where the doctor responds to her entry as an interruption (see figure 7.2). At 01:10:00 he turns his upper body around to learn about the nurse's errand even though the patient continues: *and then I called (xxx)* (see picture B). From that moment the doctor does not gaze at the patient for 21.3 seconds. The doctor perceives the sheet, which the nurse holds in her hands as she approaches him, and right after he receives the paper he utters: =*thanks*, overlapping the patient's utterance. The interruption immediately leads to a change in the interactivity trajectory. In figure 7.2 this is indicated as a transition phase form *dialogue* to *constrained multi-tasking* as the conditions for fulfilling both activities effectively decrease. As the doctor responds to the nurse's action, he also shifts his attention from the patient to the artefact and the nurse. In this way he interrupts his own task and increases the stress level in the cognitive system between him and the patient. The system's boundary conditions are vulnerable as caring for the patient becomes secondary to responding to a colleague's request and scrutinising the newly received information further. The doctor gazes at the sheet and his responses are late. In the following nine lines from the transcript it appears how the doctor's prioritisation stands out through his late or absent minimal responses.

```
4.    01:09:60, P:    and then I called (xxx) and they were not home and then I called (xxx)
                      and they were not home either=
5.    01:12:80, D:    =thanks
6.    01:13:40, ps.   (1.1)
7.    01:14,50, P:    and the duty doctor was closed and and [it all (.) fell apart (.) so I
                      thought about calling 911
8.    01:16:80, D:                                           [OH
9.    01:20:60, ps.   (0.6)
10.   01:21:20, P:          i- it was not so bad anyway right
11.   01:23:10, ps.   (2.1)
12.   01:25.20, D:    no=
```

To the patient's utterance: *and they were not home either*= (line 4), the doctor does not respond and a lapse of 1.1 seconds emerges (line 6). The lapse marks a break in the interactivity flow. The interactional fluidity and the interdependency between the two are constrained. However, the patient continues: *and the duty doctor was closed and and*, (line 7), and the doctor produces a late response *[OH*, (line 8), remarkably higher than his normal volume. After the patient has uttered *it all (.) fell apart* (line 7) she holds a brief pause before continuing. This pause is an obvious transition-relevant place (Sacks et al., 1974) where the doctor could comment with a continuer or express an understanding of the uncomfortable situation the patient has been - and still is – in, but the doctor neither respond verbally nor non-verbally. The patient then uses a logical connector: *so* (line 7) and concludes that she was thinking about calling 911. The whole utterance (line 7) reveals the serious and intimate concerns the patient has had about her own medical and mental condition, but the doctor barely responds to it. Rather, he continues to gaze at the sheet. After a 0.6 second pause, the patient finally elaborates, that: *i- it was not so bad anyway right,* (line 10). The patient now explicitly seeks confirmation from the doctor who does not respond. A lapse of 2.1 seconds emerges (line 11) and finally the doctor confirms. Offhand, from the result of this interaction, the doctor appears inattentive and preoccupied with other stuff. Thus, the main question is, why did the doctor change his orientation from the patient to the nurse and the sheet he received? The answer seems to be related to temporal dynamics (Steffensen and Pedersen, 2014) beyond the enchronic timescale of interaction.

The sheet contains medical information about various measurements that have been provided by the paramedics that handed the patient over. Though this information is important just as the patient's narrative is. When scrutinising his actions further, it becomes clear that the doctor does not choose to do A or B, rather as he reads he also maintains a dialogue with the patient. He stays close to her and even though his responses are delayed he does responds – momentarily. However, as both history taking and interpretation of medical measurements on the sheet require cognitive effort, his attention and sensitivity are constrained by the nested tasks in which he engages simultaneously. However, as the situation evolves, the doctor engages more and more in the reading task than in history taking.

The initial interruptions do not just have immediate effects on the interaction; they change the interactivity flow from dialogical and caring to monological and constrained.

The situation deteriorates as the doctor becomes cognitively overloaded as the number of interruptions and expectations to act in a specific way increases. Eventually, this dilemma leads to a task-switch and communicative breakdowns.

7.2.2 When caring for more than the patient becomes a constraint for task performance

In what follows, it is scrutinised how five interruptions affect the interactivity further. First, the nurse interrupts the doctor-patient interaction as she makes herself heard above their conversation and second an incoming call interrupts several times and it eventually prompts the doctor to abruptly drop the conversation completely. Despite the two previous interruptions, the patient continues her narrative even though the doctor only reads in the sheet (see picture E). The patient is interrupted three times in just one sentence (line 14, 15 and 16).

Almost immediately after the patient resumes her narrative (line 13), the nurse interrupts as she asks the medical laboratory assistant for some specific information (line 14). The distance between the nurse and the medical laboratory assistant prompts the nurse to speak *over* the patient. No one is paying direct attention to the patient, but each team member (the medical laboratory assistant, the nurse and the doctor) is occupied with individual tasks that are valued higher than the dialogue with the patient. The patient, however, does not stop talking, but mumbles something unrecognisable into the nowhere, when the phone rings and interrupts her verbal utterance. The patient appears oblivious to the interruptions and she continues her narrative in direct continuation with the ringing and as she finalises her utterance: *to the toilet ri[ght* she is interrupted for the third time by a second ringing. At 01:32:50 there is an overlap of interruptions. The patient seeks confirmation: *ri[ght* as the phone rings and the doctor utters *[yes*, (line 17). The doctor has gazed in the sheet for 17.70 seconds and as he responds to the patient's statement in line 13 he does not gaze at the patient, rather he briefly gazes at the phone's display on which the incoming number appears (see picture D), but he still does not respond to the call, even though its ringing prompts his orientation to a third element in the diagnostic event. The phone interruption is thus defined as a secondary event pivot that leads to a second change in the interactivity as the stress level increases further: the doctor needs to engage in dialogue, comprehend the information on the sheet, interpret the relevance of the incoming call and perceive the situation as a whole in order to decide how he should respond to the multiple disturbances. In figure 7.2 this is indicated as: s*tressed multi-tasking*.

At that moment the doctor struggles to balance multiple activities simultaneously: taking the patient's history, reading in the sheet and containing the interruptions. The patient is persistent and continues to ignore the ringing and completes a point in her narrative: *and then I had to call my daughter who says to me mum this is not (.)* (line 18). As she starts her utterance, the doctor gazes on the phone, but as the patient holds her breath for a short moment *(.)* the doctor gazes at the patient again who continues: *this is not [(xxx)*. As the patient utters something unrecognisable she is interrupted for the third time by the ringing

phone, which still does not prevent the patient from finalising her utterance: *it is blood=* (line 18). The doctor immediately follows up on this utterance and repeats the patient's last three words: *=it is blood,* and continues: *I have to take this one* (line 20). He then responds to the call, walks away from the patient and gazes out in the room as he speaks on the phone (see picture E).

The final ringing is identified as the primary event pivot that leads to a task-switch. In figure 7.2 its consequences are defined as changes in the interactivity trajectory and the change is characterised as: *history-taking on stand-by.* As the doctor finally responds to the incoming call and leaves the room, he re-enacts a value hierarchy that leads to the breakdown of the cognitive system, both functionally (goal-orientation) and interpersonally (seeking good prospects). In my data, dysfunctional interactions often emerge as a person has low multi-task tolerance. In this case, the cognitive event is characterised by multiple event pivots that finally lead to a task-switch (see figure 7.2). As this doctor is forced to respond to multiple demands within the cognitive system, he loses overview. The interesting questions are why the doctor chooses to answer the phone call during another task and secondly why it – when he chooses to do so - takes him such a long time to respond to the incoming call? The cognitive patient-doctor system is constituted by moral values such as caring and trust, and it is a dialogical and situational system that only exists for a limited time. However, the doctor is also morally and socially obliged to maintain a relationship to non-local, though long-lasting social systems, for instance systems that include other colleagues and management staff.[27] Such systems consist of values that guide healthcare professionals' behaviour even though they are not physically present (Bang and Døør, 2007). "Humans are always interdependent with others, although the degree and kinds of interdependencies will of course vary with individuals, cultures and situations" (Linell, 2009:13).

For the doctor to maintain a good reputation he is dependent on organisational credibility, which he achieves by being sensitive to social systems and responding to the phone call interruption. As non-local relationships matter in local interaction, it has consequences whether team members follow protocols and orders or not. The phone call symbolises an anonymous 'other' (Linell, 2009), and depending on how the abstract and trans-situational other is managed, it guides the local actions in a certain direction. In this context it means that the doctor is expected to respond when a superior seeks contact. If he chooses not to do so, he can be reprimanded. Answering the call thus realises important values within the social system. As caring within the social system is achieved by responding to the call, caring within the dialogical system is realised by not-responding to the call. A dilemma emerges, as the doctor is unable to engage in dialogue and respond to the interruption at the same time. As the doctor sees no other solutions to the dilemma, he needs to choose between caring for the dialogical system or the social. The doctor hesitates and postpones answering the call, which indicates a double sensitivity towards both local

[27] Confer section 3.3.1 for an elaboration of Steffensen's definition of dialogical and social systems (Steffensen, 2012).

interaction and non-local expectations. However, the stress level increases: the phone has rung three times and will soon stop ringing. If he does not respond in time, his behaviour could be categorised as inattentive from a social systemic perspective. Further, while the patient might have felt the interruptions as constraints for dialogical interaction, her 'ignorance strategy' enables her to treat the first six interruptions as non-interruptive. Her strategy complicates the doctor's possibilities for managing the interruptions as interruptive as this strategy requires that he interrupts the patient and undermines her strategy. If the patient had oriented to the interruptions as such, conditions for dialogical coordination were better, as there would be a shared agreement about the situation's complexity. That the doctor does not respond immediately to the call is thus interpreted as a sign of caring for the patient even though his behaviour appears hesitant and non-engaging. The main problem with the doctor's behaviour when he becomes stressed by the pressure of time (the third and last ringing), is that he is forced to find the first possible completion point and interrupt the patient by announcing that he is going to respond to the call (line 20). The second problem relates to the way he manages the phone call. Before the doctor leaves the room, he orients to the nurse and asks for permission to leave for a short moment as he points towards the door (see picture F). The nurse agrees and the doctor leaves without informing the patient, without looking at her, and without letting her know what happens and for how long he will be gone.

Together the number of interruptions adds up and results in a task switch (see figure 7.2), and it attests to how the doctor, in the end, prioritises the organisational system and its authorities at the expense of dialogue with the patient. The situation changes as disturbances within the interactivity trajectory make the cognitive system disintegrate and reorganise its boundaries; in this case with a dysfunctional outcome in consequence. While the doctor is cognitively overloaded by the disintegration, the patient is emotionally affected: she withdraws and she does not respond to the doctor's explanation: *I have to take this one* (line 20). Rather, she stares vacantly into space without gazing at the doctor or responding to the announcement.

From the moment the patient arrives the medical team still does not know what caused the severe rectal bleeding, and it is a serious medical condition. Thus, from a patient perspective, the interaction with the doctor does not reflect much understanding and the logic of the system are not immediately transparent, explicit or caring: "all doctors and health systems purport to put patients first, but ample evidence shows that it often doesn't feel that way to patients. They regularly feel like cases rather than people, and what is important to patients is often different from what is important to doctors" (Smith, 2003:1433). The doctor's performance appears irrational and insensitive since the patient, in the end, is valued lowest in a diagnostic situation. Paradoxically, the negative outcome overshadows the multiple failed attempts to maintain a dialogical relation with the patient.

7.2.3 Seeking good prospects

The multiple interruptions do not just disturb cognitive activity they also affect the interpersonal relation between the doctor and the patient as well as the flow of interactivity in a way that impedes the completion of a shared task. Thus, even though the underlying intentions behind interruptions are only addressed to one person, the interruption itself often disrupts the current undertaking of a cognitive system.

Analysis shows how interruptions affect the flow of interactivity as change in gaze, the handling of artefacts and values-realisation within multiple fields lead to local disturbances in the cognitive system. The system appears to have reached a peak level of cognitive load and as a consequence the boundary of the dialogical system between the doctor and the patient dissolves and he switches from history taking to another task. The doctor's actions, thus, are caused by stress rather than cognitive prioritisation. When practitioners manage interruptions, the strategy is decisive for how they bounce back from the interruption. Rather than arguing that doctors should always prioritise completion of on-going local tasks and ignore interruptions, I argue that they should be equipped with abilities to manage interruptions efficiently and in a caring way. Hence a functional and dialogical approach to interruptions is based on an evaluation of the situation. The doctor's attempt to care for the patient by postponing the task switch entails a hectic situation where he is forced to act. He could have distributed the responsibility across the team (this is what the following case shows), responded immediately to the interruptions to avoid a stressful interaction situation or briefly explicated why he needs to respond to the call.

Hodges argues that caring in the long run depends on realising multiple values over time. With an example he argues that in an experiment where people should tell the truth, they tend to both tell the truth (truth-telling) and sometimes the adverse happens as they honour other people's understanding of truth (caring) (Hodges, 2009). In the medical ward interruptions are not dysfunctional *per se*. Responding to interruptions only become problematic, if it indicates a fixed attention-hierarchy and it happens again and again without prioritising the patient. Patients are aware that much goes on in the ward and the healthcare practitioners are busy, however when they feel overlooked and valued lowest *by default,* the boundary conditions are challenged. Thus, the healthcare practitioner must treat interruptions situationally: and in the long run a heterarchy of attention tasks will emerge.

In contrast, in another case a primary doctor interrupts history taking, as she is needed outside the ward. As she leaves the ward, she explicates that part of her job description involves her presence at multiple locations at unpredictable times, but that she will be back as soon as possible. She further excuses this interruption-practice, so the patient is left with the feeling, that it is not the doctor's decision or prioritisation but the work procedures that makes her respond to interruptions during conversation.

As we have seen, interruptions do more than distress working memory, they also affect sensitivity and inter-bodily dynamics in a way that impairs the interpersonal relationship between healthcare practitioner and patient. In the next section, it is shown how interruptions can be managed to avoid pivotal disturbances.

7.3 Case II: Team coordination as values realisation: managing interruptions so they do not interrupt

This case focuses on how a telephone interruption is successfully dealt with during history taking. A novice doctor talks to a female patient who presumably has a serious infection that causes breathing problems and a bad cough. She is weakened, dizzy and exhausted. The nurse observes the interaction and she is ready to assist in getting the measurements they need. The layout is visualised below and followed by a transcript that shows what happens before, during and straight after the interruption occurs.

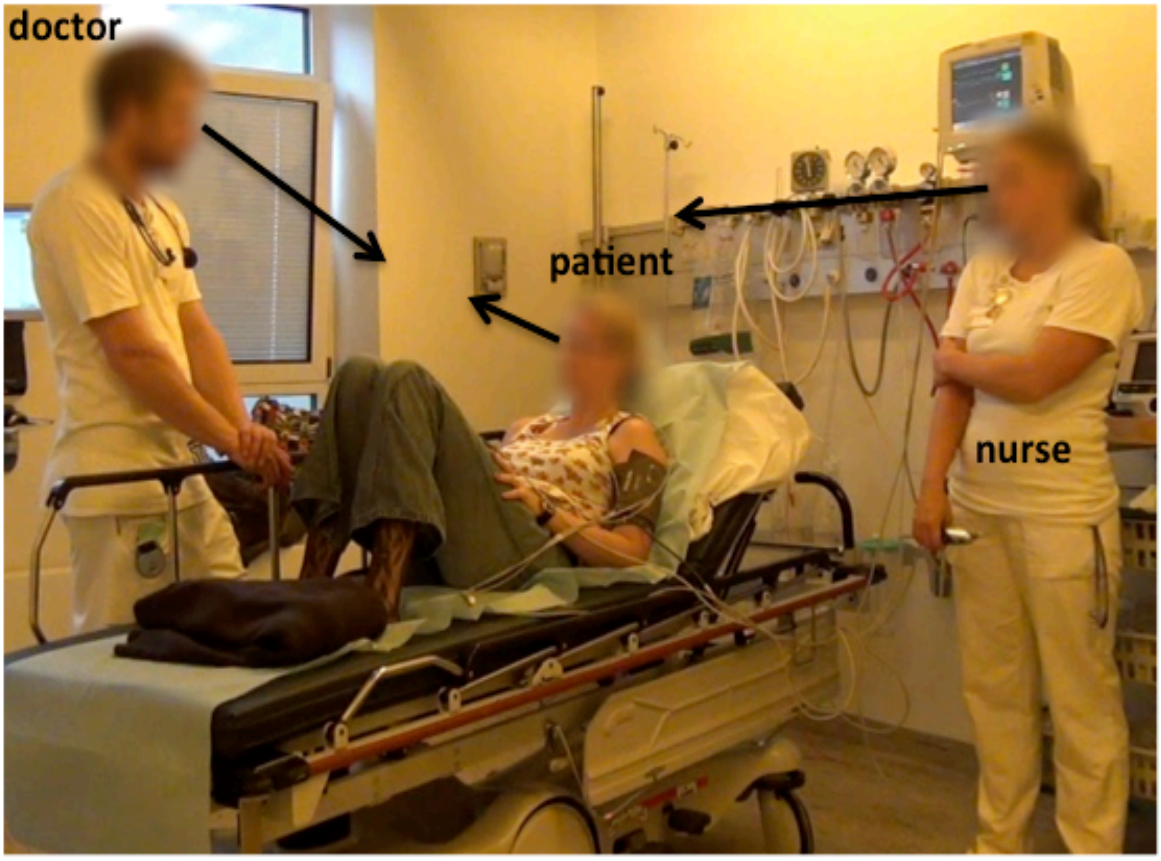


Figure 7.3: Overview of the layout: interruptions in teams

Transcript 7.2[28]
Duration: 00:41.80 minutes

DANISH ORIGINAL

1. 00:00:00, D: har du noget åndenød synes du
2. 00:01:10, ps. (0.8)
3. 00:01:90, P: altså jeg trækker vejret overfladisk
4. 00:03:90, D: ja (.) okay
5. 00:05:10, P: og det er for ikke at komme til at hoste
6. 00:06:80, D: for ikke at komme til at hoste (.) okay godt føler du at du sådan har hjertebanken kører det hurtigt hele tiden eller (.)
7. 00:11:90, P: altså efter jeg fik det der (.) sulfid i går
8. 00:14:60, D: mm
9. 00:15:00, ph ri[ng ring
10. 00:15:70, P: [der [s:ynes jeg at (.) der nogen gange er sådan
11. 00:16:10, D: [hov (nurse takes phone in her hand)
12. 00:17:80, ps. (1.3)
13. 00:19:10, P: m[en det har jeg haft (hoster)
14. 00:19:20, ph [ring ring
15. 00:21:20, ps. (0,5)
16. 00:21:70, P: d[et har jeg haft før (.) (xxx) føler jeg at (.) det lige slår
17. 00:21:80, N: [det er [nurse's name] (.) det er bare lige [doctor's name] telefon
18. 00:25:50, D: at det li:ge slår en lille kolbøtte
19. 00:27:30, P: en enkelt gang i[k
20. 00:28:20, D: [men det er ikke sådan noget der bliver ved (.) [(xxx) op og ned (.) nej [godt
21. 00:29:30, P: [(P nods 'no' with her head as she coughs)
22. 00:31:50, N: [super
23. 00:31:70, ps. (1.9)
24. 00:33:60, D: var det noget (rækker ud efter telefonen)
25. 00:34:00, ps. (0.9)
26. 00:34:90, N: det var bare om stue seks var kørt
27. 00:36:20, D: nå
28. 00:36:60, ps. (2.9)
29. 00:39:50, D: godt (.) nogen smerter mere noget kvalme

ENGLISH TRANSLATION

1. 00:00:00, D: Do you feel as if you have difficulty breathing?
2. 00:01:10, ps. (0.8)
3. 00:01:90, P: I do in fact breathe shallowly.
4. 00:03:90, D: yes (.) okay
5. 00:05:10, P: and that is just to avoid coughing
6. 00:06:80, D: to avoid coughing (.)ok fine do you feel that you have heart palpitations constanly, or (.)
7. 00:11:90, P: well after I have got this (.) sulphide Yesterday (.)
8. 00:14:60, D: mm
9. 00:15:00, ph ri[ng ring
10. 00:15:70, P: [then I [thi:nk that (.) sometimes there is a kind of a

[28] Interruptions are marked in red. *Ph* is an abbreviation for phone.

```
11. 00:16:10, D:              [oops (nurse takes phone in her hand)
12. 00:17:80, ps.  (1.3)
13. 00:19:10, P:   b[ut I have had this (coughs)
14. 00:19:20, ph    [ring ring
15. 00:21:20, ps.  (0,5)
16. 00:21:70, P:   I [have had this before (.) (xxx) feel that (.) it just somer
17. 00:21:80, N:     [[nurse's name] speaking (.) it is [doctor' name] phone
18. 00:25:50, D:   that it ju:st somersaulted
19. 00:27:30, P:   just once ri[ght
20. 00:28:20, D:               [but it is not something that continues (.) [(xxx)
                   up and down (.) no [okay
21. 00:29:30, P:                                                          [(P
                   nods 'no' with her head as she coughs)
22. 00:31:50, N:                       [super
23. 00:31:70, ps.  (1.9)
24. 00:33:60, D:   was it something important (reaches for the phone)
25. 00:34:00, ps.  (0.9)
26. 00:34:90, N:   just checking if ward six was cleared
27. 00:36:20, D:   oh
28. 00:36:60, ps.  (2.9)
29. 00:39:50, D:   well (.) any pains anymore any nausea
```

When we enter this conversation, the doctor has just greeted the patient and informed her about what he is going to do next: ask for information that enables him to reach a diagnosis. From line 1-7 the doctor and patient engage in history taking. The doctor is a novice and he has only been working at the ward for less than a week at the time of the recording. Rather unusually, he does not rely on any aiding tools during this task performance. He leans towards the patient and gazes at her as he asks for specific information. The patient gazes momentarily at the doctor and straight out when she is going to recall memory. As the patient utters: *b[ut I have had this* (line 13), the doctor's phone rings (line 14). Figure 7.4 and 7.5 illustrate how this interruption affects the current undertaking and how the medical team acts to prevent the interruption from leading to task-switch and from harming the current dialogue. This efficient team performance is initiated by the nurse's anticipatory actions, which will be investigated in detail in the following.

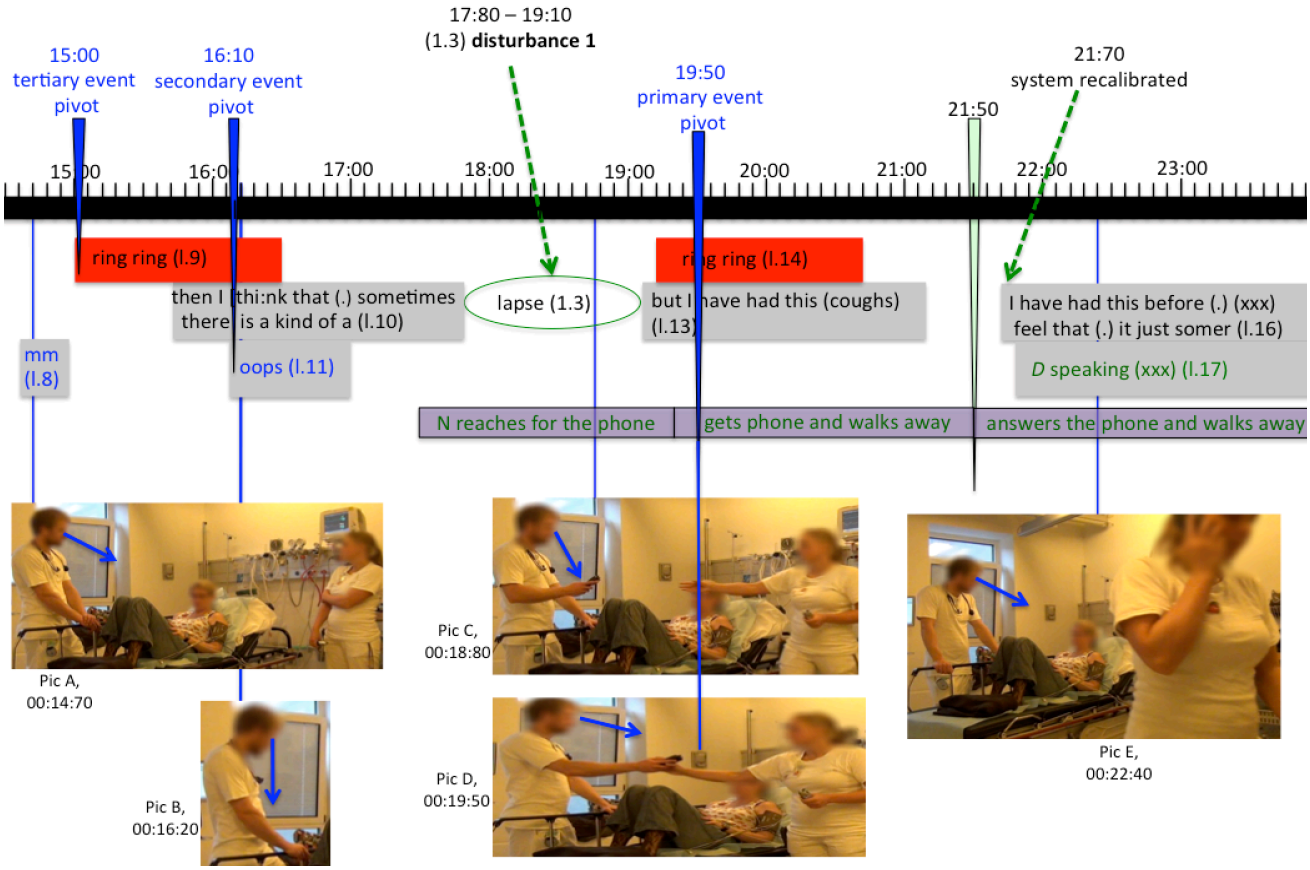


Figure 7.4: Anticipatory dynamics in interruptive practices

The black text indicates the patient's utterances. The blue text indicates the doctor's utterances, and the green text indicates the nurse's utterances

The telephone rings at 15:00 just in the patient's breathing pause (line 7). The ringing leads to several anticipatory actions (tertiary event pivot). The doctor immediately treats the interruption as relevant. Until the interruption occurs, the doctor gazes at the patient (see picture A), but at 15:70, he pays attention to the interruption as he gazes at his pocket in which his phone is located (see picture B). However, the patient overlaps the loud ringing and finishes her explanation at the same time as the doctor changes his visual orientation from her to the phone: *[then I thi:nk that (.) sometimes there is a kind of a* (line 10).

Like in the previous case, a dilemma emerges as the doctor is expected to realise values in two systems simultaneously: the dialogical system in which he engages in history taking with the patient and the social system that expects a professional, standardised behaviour: immediate response, as delayed response can lead to bad outcomes in other locations. Thus, the doctor is expected to balance caring for the patient and smooth work procedure in the ward, which means caring for colleagues and other patients. Values realisation in such two different systems is constrained and enabled by different dynamics. In the former system, inter-bodily dynamics affect decision-making directly and this was a major explanation for why the doctor in the previous case postponed his interruptive behaviour. In the latter system, rules and norms constrain the moral obligations that affect real-time

decisions.

Thus, in this case II, the doctor explicitly orients to the interruption as unfortunate: *[oops* (line 11), as he takes the phone out of his pocket. Altogether, this course of events prompts the nurse to interfere. The nurse's subsequent actions can be characterised as negative feedback mechanisms within the system that prevent latent breakdowns to emerge prompted by the tertiary and secondary event pivots (the ringing and the doctor's response to the disturbing source). The doctor's visual orientation toward the phone and his verbal utterance *oops* thus mark the secondary event pivot in the cognitive event trajectory, and this utterance affords a series of anticipatory actions (see figure 7.4). The patient does not treat the ringing and the doctor's behaviour as a reason to stop her narrative. The doctor himself seems annoyed by the interruption and as he picks up his phone he gazes at the patient who continues to speak. Just as the phone stops at 16:50, the patient gazes at the doctor and she finalises her utterance. The doctor holds on to the phone and as the nurse anticipates that the doctor probably is going to answer the call, she reaches out for it (see picture C). From the moment the nurse reaches for the phone and the patient has finalised her utterance in line 10 (00:17.80) until the nurse almost has the phone in her hand and the patient resumes her narrative (00:19:10) a lapse of 1.3 seconds elapses (see figure 7.4). The phone-switching-event is defined as the primary event pivot. It only causes a minimum of disturbance that entails that the interaction is briefly put on stand-by. Most likely, the nurse anticipates that the doctor's actions are going to interrupt the current undertaking. Thus, at a critical moment, she both offers and demands that she is going to handle the phone call. The doctor hesitates as he briefly gazes at the phone display to check who is calling before he accepts the nurse's demand (see picture C). Thus, as the patient continues her narrative in line 13, the phone rings for the second time. At the same time, the nurse gets the phone from the doctor who regains eye contact with the patient and resumes the history taking (see picture D). At 00:21:50 the nurse answers the call and walks away, while the doctor and patient continues the dialogue in the same manner as before the interruption occurred. As such the cognitive system remains intact and its boundaries are recalibrated (see figure 7.4).

While the nurse handles the phone call, she executes a nested task that the medical team needs to respond to, but she does it in a way that reduces the chances for cognitive overload, interpersonal breakdowns and task switch. The therapeutic alliance between doctor and patient remains intact. The patient's behaviour indicates that the disturbance or 'noise' in the cognitive system is almost unnoticed by her, and the doctor and patient continue without any problematic breaks or disturbances.

The team performance is highly coordinated and it enables values realisation in a constrained situation with a minimum of dysfunctional outcome. As the doctor cannot do two things simultaneously, the nurse enables him to continue with his initial task as she performs the second task for him. This coordination succeeds as the nurse anticipates the flow of actions and the doctor relies on and trusts the nurse's prioritisation. Their coordinated behaviour enables them to embrace complex and diverging expectations and realise multiple constraining values. As the team organises the values in a heterarchy,

decisions can be made as a result of emergent properties of the environment combined with expectations for goal-orientation. Specifically, it is due to the distributed properties of the cognitive system that multiple values are realised simultaneously without ordering the activities in a predefined hierarchy.

From the emergence of the first event pivot until the system has calibrated its dynamical interaction mode, 5.60 seconds pass. A few moments later, the nurse re-enters and closes the phone conversation all whilst the patient is plagued by a bad cough. The whole situation prompts the doctor to pay attention to the nurse to define which issue requires his attention the most (the patient or the interruption). From that moment a small nested activity is embedded in the history-taking task (see figure 7.5).

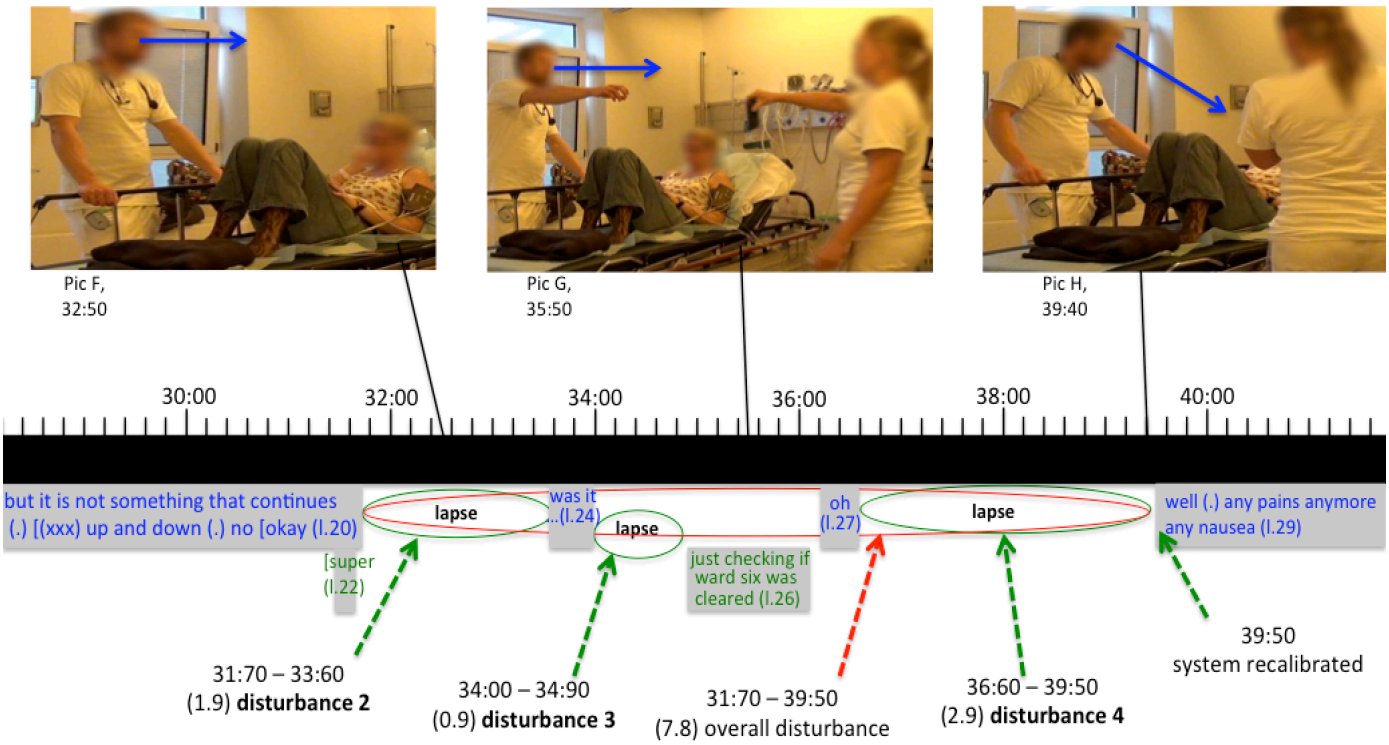


Figure 7.5: Interruptions as non-interruptive

Figure 7.5 underlines the minimal disturbances the interruption entails after the nurse has responded to the call, and finally it illustrates how this situation has affected the cognitive task of history taking overall.

As the nurse closes the phone conversation *super* (line 22) the doctor orients to her (see picture F) and he asks whether it was an important call (line 24). Briefly, the nurse updates the doctor about the particularities that do not require the doctor's further involvement, as she has solved the problem already (see picture G). The doctor acknowledges this update, puts his phone back in his pocket and reorients to the patient (see picture H).

In total, the doctor and nurse complete this nested task within 7.8 seconds. The interruption proved to be just a trifle and as such the doctor was exempted from engaging further in the intentions behind the interruption. If the interruption had required the

doctor's attention, this would presumably have been prioritised. Only in this case, it was not needed.

The way this team manages the phone interruption is an exception within my dataset. The interactivity trajectory deviates from standard situations involving interruptions. In the ward, the doctors answer their phones themselves without fail. Experienced doctors tend to answer immediately without taking time to judge from where the call is coming; in a few situations they ignore the calls if the local situation is acute and critical. Novices on the contrary tend to hesitate before they respond as the situated demands for presence and attendance often collide with non-local expectations for responding to an authority. However, the delayed response only adds further frustration and cognitive overload as shown in the first case.

Sharing responsibility for dialogical work practice and making use of the team's capabilities as interruptions occur are barely noticed in the coding. A phone call is always an interruption, but the nurse anticipates a line of actions that affords her to manage the interruption so it never becomes problematically interruptive. As the team co-act, their actions serve as negative feedback mechanisms that reduce the risk for task switch that regularly leads to human error or harms the interaction unnecessarily. The nurse actively recalibrates the boundaries of the cognitive system. In the beginning she is cognitively loosely associated to the system, however, she observes what is happening. Rather than allowing the patient-doctor relation to break down she enables the doctor to maintain ongoing dialogue and history taking. As she turns around and walks into a corner of the room as she handles the call, she disintegrates with the doctor-patient system. Hence, her task performance does not disturb or interfere with the doctor's task performance in a way that has consequences for the functionality of the cognitive system.

In the ward, interruptions appear to be imposed on individuals; for instance when a caller seeks to reach a specific practitioner. However, there are alternatives to individual problem-solving. As the latter case showed, relying on the distributed qualities of team constellations enables caring for the patient by prioritising differently within the same situation. The team's coaction enables it to complete a shared project and to meet the broader organisational needs constituted as procedure following, as well as local needs in interaction. By acting individually together, they multitask. The overall multi-task tolerance is high, even when challenged by interruptions and the team deals with the competing requests in a way that replaces a traditional task hierarchy with a shared task heterarchy. This performance minimises dilemmas and favours several groups of people simultaneously: the organisational system, the medical team and the patient.

7.4 Conclusion: wayfinding in emergency medicine

The first case presents a general interruption-driven practice involving a novice doctor operating in a stressful environment. Interruptions lead to cognitive overload as multiple demands constrain local dialogue and task performance. The second case unveils how successful interruption management is achieved through team coordination. The nurse's

anticipatory behaviour and the way the team balances multiple expectations simultaneously enable a dialogical and fluent diagnostic process where the risk for human error is remarkably lower due to the high multi-task tolerance of the team. Attention, sensitivity and a caring attitude towards both patient and the organisation's general needs are the beneficial and functional result of the team's behaviour. Most importantly, the distribution of task performance enables an efficient performance without reducing or losing power and responsibility. As the nurse is not allowed to make decisions within the doctor's domain, she can offload the doctor and facilitate the information processes so information is given at the right time. As the interruption was just about information passing, no decisions were made, and no responsibility domains were challenged. In other words, the nurse could perform this task just as well and unproblematically as the doctor. Paraphrasing Hodges (2007a) their dialogical behaviour is a form of wayfinding that the cognitive system as a whole benefits from, both functionally and interpersonally.

As the cases show, patients tend to have a high tolerance to interruptions coming from non-human sources. However, in cases, when healthcare practitioners left the room, they often uttered a frustration because of the practitioners' interruptive behaviour: they would say to me (I remained in the ward with the patients and their relatives) that it was not because they were interrupted as such, but because the practitioners were gone for an unknown amount of time and the waiting time was almost intolerable for the patients who were seeking clarification and expressed a need to being taken seriously. Frustrated and irritated patients do not seem to be the intended outcome of the healthcare practitioners' responses to interruptions; rather, they are unaware of how patients make sense of the situations when they leave the room. On the other hand, healthcare practitioners appear to be affected by interruptions in the history-taking task and there is a tendency for novices to attempt to balance multiple expectations in a way that leads to more stressful situations. Novices with less automatised diagnostic skills display a low multi-task tolerance as they are cognitively limited and spend more time on navigating through the complexity that an interruption-driven situation entails. Eventually, when a maximum stress level is reached, the novice employs a strategy that allows for one thing at a time and they tend to prioritise expectations from non-local systems.

Experienced healthcare practitioners prioritise and handle dilemmas by doing one thing carefully at a time and contain local frustration. In the previous chapter 6.2.2 the doctor simply avoids responding to the interruption and refuses to switch task and eventually, the nurse, a less busy team member at the time, handles the interruption. Thus, the doctor prioritises the current undertaking, and contains the stressful situation caused by an increasing noise coming from the interrupting source. Other experienced doctors, I have observed, ignore incoming calls, as they know the call is diverted to another colleague, and that in 'true' emergencies they will be interrupted by alarm systems etc. However, such deviant and 'disobedient' behaviour is related to culture and expertise and for a novice it can be difficult to know when not following protocol is useful and acceptable.

8. Medical cultural dynamics: emotions and role hierarchies

8.1 The biomedical model in emergency medicine: cultural challenges and values

Medical practitioners are constrained by cultural dynamics shaped by non-local timescales (Pedersen, 2010; Pedersen, 2012; Pedersen and Steffensen 2014, Steffensen et al., 2010; Cowley, 2011). In real-time interactivity, cultural dynamics such as normative embodied procedures mesh with situational dynamics that become local affordances for action. When these dynamics diverge and provide different action possibilities they are managed through (dys)functional coordination in the local. As demonstrated in the previous chapter, values are important for the understanding of the enabling conditions for such coordination as values underlie a self-organising constitution of boundaries in an ecosystem (Hodges and Baron, 1992; Hodges 2007a; 2007b). With the theory of values realisation, this chapter investigates how much power cultural dynamics have on situated interactivity, and at the same time how culture is dynamically shaped by embodied behaviour, and eventually how this process relates to the emergence of error cycles. Initially, two main cultural challenges that appeared in the coding are elaborated and related to general cultural challenges in the medical sector. The challenges concern the emotional consequences of a biomedical model in diagnostic processes in emergency medicine and the function of role hierarchies in emergency medical decision-making.

First, the biomedical model in Western medicine favours a logic that prioritises objective facts over emotional and subjective experiences. This model implies a pre-defined understanding of proper clinical behaviour. The model, thus, shapes a specific kind of actions and frames decision-making in situated interaction in a fixed fashion that constrains flexible adaptive behaviour. Put simply, the biomedical model dominates and contributes to a fixed view on healthcare: “The biomedical model has become a cultural imperative, its limitations easily overlooked. In brief, it has now acquired the status of a dogma … Biomedical dogma requires that all disease be conceptualized in terms of derangement of

underlying physical mechanisms" (Engel, 1977:130). The biomedical model entails a disparity between patients' experience of *illness* and the biomedical categorisation and focus on physical symptoms, the *disease* (Putsch and Joyce, 1990). With a Cartesian rationalism, the practitioner focuses on the bodily disease as it shows for the observer and what the patient thinks and utters about his medical situation is secondary: "It has been proposed that the inability to deal with illness is a major failing of biomedicine" (Putsch and Joyce, 1990:1050).

Moreover, the biomedical model argues against emotion-laden interactivity. Especially in the emergency ward, emotional experiences are ubiquitous amongst both practitioners and patients (Angoff, 2002) due to the high level of uncertainty and the possible extreme outcome of the medical situation. Anxiety, stress, anger, withdrawal or even hostility are emotional circumstances the patient and healthcare team enact. "Yet physicians are taught to remain detached from participating in these emotions in order to maintain the objectivity thought to be crucial to accurate clinical decision-making" (Halpern, 2001:188). In educational settings, medical students are taught to achieve the 'detached concern' and the student learns to objectify and intellectualise emotion-laden experiences as a means to distance himself from his own anxiety and fear and maintain a rational focus on the task (Halpern, 2001). Within my dataset, this distance is not just symbolic and mental. It shows in a physical moving away strategy and a fear of being physically close to or *with* the patient.

From an ecological perspective, emotions are not individual mental representations; they are dialogically tied to interactivity (Jensen, 2014a). In a similar vein, Dewey argues that emotions are not distinguished in internal biological states and external expressions; instead he defines *situations* as saturated with emotionality (Dewey, 1958). Such approach allows for analysing emotions "as processes of organism-environment interactions" (Colombetti, 2010:157). In contrast to this view, the biomedical model prompts healthcare practitioners to act less dialogically and increase the relational distance between them and the patients. In the analyses it is shown how the fear of emotions manifests in the way the healthcare practitioners avoid physical contact and attendance with the patient, for instance by relying more on medical verbal explanation than inter-bodily dynamics. The chances for misunderstanding, frustration and human error increase as practitioners avoid physical rapport with the patient (Putsch and Joyce, 1990). Particularly, Dr. Verghese, a physician, professor *and senior associate chair for the Theory and Practice of Medicine at Stanford University School of Medicine in California,* has studied the absence of 'social touch' in contemporary medicine. He continuously underlines how the frequency of, and the time spent on bedside examination are decreasing and how this tendency entails an increasing distance between the patient and the healthcare practitioner. Paradoxically, he argues, in our technological age the most important innovation in medicine is the power of the human hand, which is not acknowledged within the field: "we touch our patients less and less: the physical exam, the skilled bedside examination of the patient, has diminished to where it is pure farce" (Verghese, 2009:1178). Other practitioners within the field of medical education underline how important social touch is and how it is rarely, if ever, a focus area

of education: "Learning to effectively use procedural and social touch together is important in limiting risk and, when done well, can enhance the power of the clinical moment" (Searles[29]). Further, Goodwin et al., (2012) argue that: "touch constitutes one of the modalities that has distinct temporal qualities; in contrast to speech, touch […] has the potential to endure. […] verbal requests do not need to be repeated; rather, their interactional relevance can be effectively extended through the use of the tactile modality" (Goodwin et al., 2012:8). That means that laying a hand on a patient's shoulder during history-taking, for instance, can be a way of realising multiple values simultaneously as the enduring touch calms the patient down (caring) when the healthcare practitioner at the same time is able to maintain a bio-medical focus on the task. As such he can ask relevant questions when he touches the patient and the emotionality of the situation is more likely to be contained in a functional and caring manner.

Unfortunately, within the literature refereed to above, the opposite (a bodily less engaged attitude in the medical encounter) seems to be prioritised. This development within the field of medicine is a consequence of the technological advances within the field that prompt practitioners to orient to a representation of the real patient, a patient that is clothed in binary garments, also referred to as the *iPatient* (Vergehse, 2009). The technological development provides affordances (technological artefacts e.g.) that underwrite the scope of the biomedical model. While the development enlarges the distance to the real patient (see also chapter 5.3.1 and chapter 6.3.1) it feeds positively back on the biomedical culture. This is the focus of the first case in this chapter.

Another cultural and general issue of debate concerns the function and consequences of professional role hierarchies in medical decision-making. Role hierarchies contribute to fixed understandings of who is in charge and responsible for various decision-making processes. Potentially, such hierarchies scaffold efficient subdivision of tasks and responsibility, but they also become a pitfall for individual and monological behaviour when dilemmas emerge, problems arise and the unknown surfaces (Pedersen, 2010). This will be investigated in the second case.

While the medical culture is characterised by strong expectations of the different roles in the medical team, practitioners easily please those same expectations. The healthcare sector places medical roles in a hierarchy that is characterised by differences in responsibility, control, authority, knowledge, and so on. This is not just implicit. Differences appear in artefacts such as salaries, clothes, equipment and even factors such as how practitioners interact and behave. The artefacts function as affordances for acting in hierarchies of fixed roles. Working in healthcare, however, is also working in a learning practice, where team members learn from each other. Given this way of thinking, members of a team must accept and also approach knowledge sharing and dialogue. A large part of the problem with role hierarchies lies with a social system that consists in culturally and historically defined norms and procedures, which, in effect, come into conflict with a need

[29] http://www.mbc.ca.gov/Licensees/Sexual_Misconduct/Touch.aspx, May, 18th, 2015.

for more flexible and collective procedures.

It is hypothesised that cultural dynamics are more powerful than situated affordances in local decision-making processes. The chapter uses two cases where cultural dynamics clash with local interactivity to investigate to what extent healthcare practitioners draw on non-local cultural affordances (Pedersen, 2010) for action and respectively how flexibly they adapt to the changes within the environment.

This chapter pays particular attention to how cognitive events are constrained by cultural dynamics. It uses CEA as a method for identifying the relevant event pivots that connect with non-local understandings of how problems are managed. As such, it also draws on longer timescales to show how situation-transcendent dynamics affect local organisation in interaction. Specifically, dialogical theories and values-realisation theory are applied in the analyses. Thus, by applying an ecological values-realisation perspective, healthcare practitioners' attempt to navigate and manage such challenges can be investigated as sense-saturated, coordinated self-organising processes that guide action and lead to results (Hodges and Baron, 1992; Hodges, 2009). To balance and realise multiple values without violating the boundaries of a cognitive system requires an overview of the situation and an understanding of how experience and cultural norms scaffold and inhibit local decision-making.

8.2 Case I: the social touch

The first case presents two excerpts that involve a patient who literally reaches out for the doctor. It investigates what happens when the biomedical model dominates in diagnostic situations and fixates healthcare professionals in a strict problem-solving mode of interaction. It further investigates how and why emotional dynamics of interactivity are suppressed and it outlines the consequences of this absence for dialogical task achievement. The aim is to demonstrate the challenges a bio-medical perspective entails for dialogical diagnostic situations and how touch appears to be crucial in interactions where the unexpected permeates the situation.

In this situation, the doctor, a young, female novice struggles to get hold of the patient's unstable and critical medical condition. The patient is an elderly woman who just arrived with 911 and her condition is critical, unresolved and unstable. Her husband sits next to the patient and he plays a key role in the history taking process, as the patient's speech is impaired due to respiratory problems. Below is an illustration of the layout.

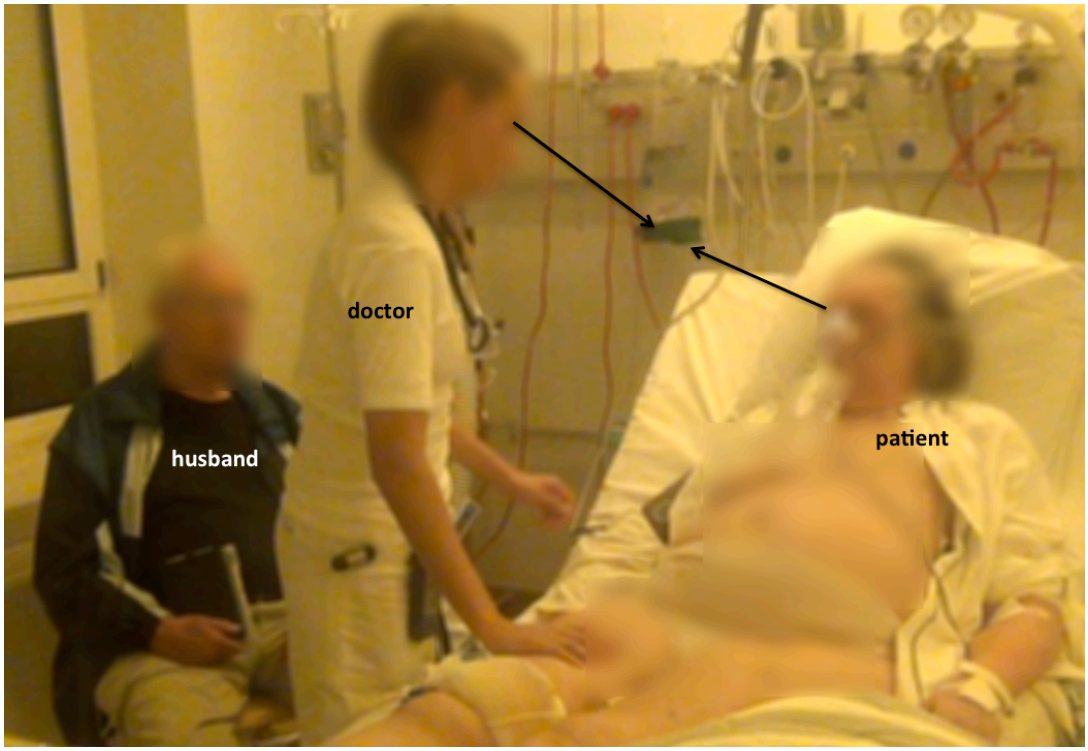


Figure 8.1: Overview of the layout: touch

8.2.1 The soothing effect of touch and emotional alignment: patient initiated touch

As we enter the interaction, the doctor is faced with the indication of the patient's dangerously unstable oxygen saturation, which is documented by measurements appearing on the screen above the patient. The doctor fixates on medical measurements and the patient and the patient's husband have not been informed about the procedures or general agenda. Rather, they observe the doctor's actions as a step-by-step procedure, without knowing where they are heading in advance. While the doctor keeps observing, they wait. The patient, who is scared as she presumably just had a blood clot in her lung, initiates an emotion-laden interaction mode, which indicates a need for contact. As her speech is impaired due to her respiratory problems, she relies primarily on non-verbal interaction. When the doctor has observed the measurements for 8.7 seconds, the patient reaches for the doctor's hand. This patient initiated touch seems to surprise and make the doctor uncomfortable to such a degree that she awkwardly withdraws from the interaction. This event is visualised in the following figure 8.2 that indicates the exact timing of the multiple dynamics in the interactivity and the inter-bodily dynamics that lead to system disintegration.

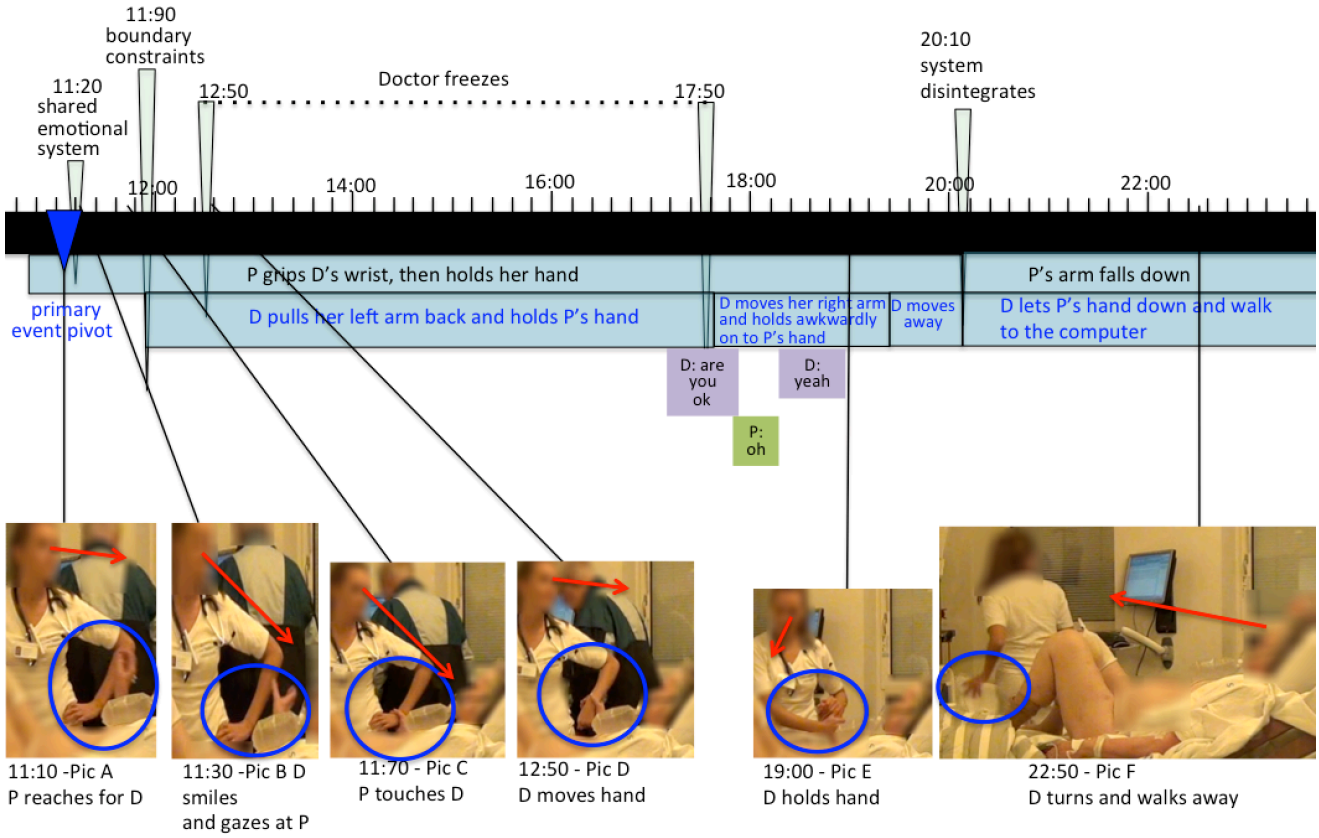


Figure 8.2: Shared emotional system: touch and task performance

The figure emphasises the behavioural dynamics that affect both the emotional alliance between the doctor and the patient and prompt the doctor to switch task.

Before the patient initiated touch, the patient and the doctor were not engaged in joint coordination. However, throughout the whole excerpt the patient gazes at the doctor. At 00:10:70 the patient initiates a dialogical movement; she reaches for the doctor's hand (see picture A). This action is characterised as an event pivot that prompts the doctor to re-orientate to the patient. Thus, 0.6 seconds after the patient initiates the movement, the doctor perceives the behavioural change and gazes in the direction of the patient (see picture B). At that moment, 00:11:30, the patient and doctor align and a shared emotional system emerges (see figure 8.2). 0.4 seconds after they have gained eye contact (00:11:70), the patient touches the doctor and holds on to her wrist (see picture C).

With Hodges (2007a), caring is what makes social coordination and coaction possible. Before this moment, coordination was absent and the doctor engaged in individual problem-solving. Far from being ignorant, the doctor's individual-oriented behaviour is likely to be caused by stress and overload as her attempt to solve the medical problem reduces her sensitivity to other elements in the situation. However, no matter the cause, the function of the doctor's behaviour results in a need for coordination from the patient's perspective. The patient literally turns the doctor's attention away from the screen towards her, which changes the flow of interactivity. As this happens, the emotional state of the patient is no longer an individual private feeling, it is part of a shared experience that

invokes emotions in the doctor as well, and she smiles at the patient. By so doing, the doctor acknowledges that the patient wants something from her that is different from what a medical individual-oriented approach provides. The reciprocal relationship between the doctor and patient necessarily makes both parties emotional accountable for the interaction and to maintain this relationship requires that they coordinate their behaviours. As shown in figure 8.2, coordination ceases and the shared emotional alliance lasts only a short while. The reason for this termination is analysed after the description of what happens.

Immediately after the patient touches the doctor (0.2 seconds), the doctor re-orientates to the observation task and gazes at the screen as she smiles. She moves her arm further away from her own body and holds the patient's hand in an awkward position (see picture D). This movement, and her change in gaze direction, together serve as a boundary condition that threatens the newly established emotional system (see figure 8.2). If maintained, the emotional and vulnerable relationship between the two needs to be nourished through dialogue. However, the doctor continues to hold on to the patient's hand but her body freezes for 5 seconds as she primarily stares at the electronic display above the patient's head (see figure 8.2). Thus, 5 seconds later, 00:17:50, the doctor initiates a closure; without looking at the patient, she uses her right arm to remove the patient's hand as she gazes at the patient's medical paper record, which is located next to the patient (see picture E). During this activity she asks whether the patient is all right as she removes her hand (see figure 8.2). The patient who has difficulty in speaking hardly reacts and as the doctor lets go of the patient's hand, she utters *yeah,* then turns around and walks to the electronic computer with the paper record in her hand (see picture F). The doctor-patient system disintegrates both emotionally and cognitively, and caring dialogue is replaced with monological behaviour. As the doctor fails to care for the patient and as she prioritises the medical task over the interpersonal relation with the patient, the system dissolves (Hodges, 2009; Hodges and Baron, 1992). Physically, the doctor walks away without scrutinising the intentionality behind the patient's request. There are several explanations as to why the doctor withdraws, which will be elaborated next.

Patient initiated touch is rare and it seems to have an interruptive function on the doctor's individual agenda. In this case, the doctor's reaction to the patient's emotional behaviour is minimal and brief. From her body language she appears uncomfortable with the patient's direct contact and she awkwardly removes the patient's hand and puts it down (see picture D-F). Interestingly, the doctor is not uncomfortable with physical touch when she establishes the contact. Several times during the diagnostic event she strokes the patient's arm or thigh and calms her down (see figure 8.1). Yet, when the touch is patient initiated, she appears uncomfortable and unable to engage emotionally in a dialogical sense. Problems arise when changes in the affordance layout are unpredicted, unusual or afford the doctor to re-prioritise her orientation, in this case from the bio-chemical patient represented by the screen to the emotional living patient. Further, the complexity arises when the patient asks for something during a task performance. When Verghese (2008) underlines the importance of the social touch and bedside examination he also explicates the dilemma that practitioners face in practice:

> When I stroked a patient's palm and caused a twitch of the mentalis muscle under the chin — the palmomental reflex — it was as if I were performing magic. Still, the demands of charting in the electronic medical record (EMR), moving patients through the system, and respecting work-hour limits led residents to spend an astonishing amount of time in front of the monitor; the EMR was their portal to consultative teams, the pharmacy, the laboratory, and radiology. It was meant to serve them, but at times the opposite seemed true. (Verghese, 2008:2749)

Verghese describes the complex field that practitioners navigate in. To realise values that enable caring and efficient work practices depends on the practitioner's ability to adapt to the situation: in this case orient to the patient's needs. The situation is characterised by time pressure, complexity, rapidly evolving and changing information load with high levels of ambiguity, risks, and a high workload. In situations like this, it can feel more comfortable to draw on familiar patterns rather than caring. Moreover, flexible adaptation requires situation awareness rather than a predefined hierarchy of task performances. According to the biomedical model, medical problem-solving and emotional alliance with the patient are two interdependent tasks with a clear priority. However, ignoring the emotional patient can have fatal consequences. It can lead to frustration, anxiety and withdrawal that, eventually, show at the biochemical scale, for instance when fear causes high blood pressure, or when anxiety and confusion inhibit patients in answering correctly to vital questions etc. Further, such hierarchy is not necessary. Goodwin et al., (2012) show how touch has a long-lasting effect that can do something very different than verbal utterances. Thus, the doctor could hold the patient's hand as she continued the medical hypothesis generation alongside. The doctor faces a dilemma related to sociocultural issues and beliefs. Time is an explicit local challenge that complicates decision-making as she meets local demands from the patient and non-local expectations of medical problem-solving. Emotional interaction does not correspond with the 'detached concern' and subjective and caring dialogue complicates objective medical hypothesis generating and the doctor sees no opportunities for completing both tasks in time.

Part of the dilemma can be solved if the doctor asks for help. While the medical condition is difficult and requires all her attention and possibly even specialised expertise, the dilemma is not just related to cultural hierarchy of the biomedical model over emotional concerns, but also to one of formal roles. In the ward there are implicit rules for when it is appropriate to call for assistance. The interviews with the practitioners show that a healthcare practitioner must make sure that he or she has done everything in her power to avert the situation by herself due to lack of resources. Thus, double-checking protocols is common procedure before one asks for help. However, as the patient's condition continues to worsen, the doctor confers with her primary doctor and they agree to call for further assistance and get a doctor of internal medicine to examine the patient.

The doctor of internal medicine examines the patient. The doctor follows the medical examination intensively and momentarily she observes the medical values on the electronic display. During this course of events, the patient once again reaches for the doctor's hand. This is visualised in the following figure that indicates the exact timing of the multiple dynamics in the interactivity prompted by the patient's wish for an emotional alliance.

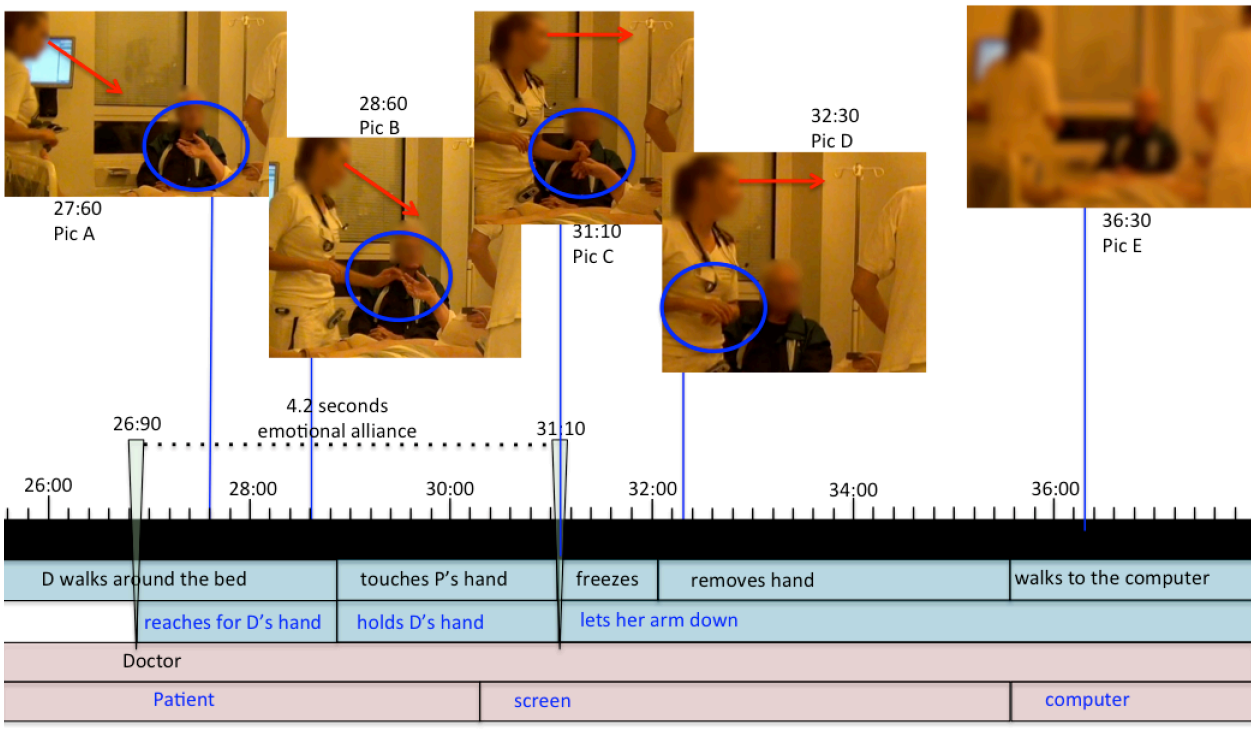


Figure 8.3: Emotional alliances through touch

The black text indicates the doctor's actions and gaze. The blue text indicates the patient's actions and gaze

The situation from before is repeated. As the doctor approaches the patient she becomes an affordance for dialogue. The patient perceives that the doctor heads toward the end of the ward where she lies, and where the computer and the electronic display are located, and she co-constructs her itinerary by requesting her attention. The doctor walks determinedly towards the patient and responds by putting her hand out. At 00:28:60 the doctor is just about to hold the patient's hand (see picture B) and she smiles at the patient. The doctor gazes at the patient and for a short moment they are aligned. However, the doctor briefly re-orientates to the screen located above the patient's head. It shows how the doctor is alert and needs to deal with medical problems, as she also needs to contain the emotional alliance with the patient. From the moment the doctor gazes at the electronic screen, only 0.8 seconds pass until the patient lets her hand down again (see picture C). As this happens, the emotional alliance between the two ceases. As a consequence of the breakdown, the patient withdraws and the doctor freezes for a moment before she places her hands on her hips and continues to observe the measurements provided on the screen (see picture D). Finally, the doctor turns around and walks to the computer (see picture E) exactly as she did in the previous excerpt.

During this episode no one says anything. As the doctor and patient align, a special kind of emotional inter-bodily dynamics emerge. As Jensen (2014a) argues, language is inherently affective and emotions are an integral part of language and, thus, interactivity. When socio-physiological constraints are experienced in interaction, their effects shape the interactivity trajectory. In this situation, when looking at the interactivity trajectory, the patient's reaching

out for the doctor manifests as deviant dynamics in the trajectory. The default dynamical flow is characterised as relatively stable and with few changes. The patient primarily focuses on breathing and neither says nor does anything else while the doctors are occupied with individual medical tasks: examination and observation. Conversely, as the patient interferes with that practice, the dynamical flow changes, and the emotional commitment changes concurrently.

For 4.2 seconds the patient and doctor are emotionally aligned, even though the doctor does not gaze at the patient for the last 0.8 seconds of the alignment, see figure 8.3. Touch and eye contact appear to be important elements for facilitating emotional alignment and commitment. From a biomedical perspective, this situation is not a desirable position for a doctor to be embedded in and the 'detached concern' does not incorporate such incidents. Hence, an individual-based approach fits the bio-medical model and this could be one reason why the doctor hesitates in the patient initiated requests for intimacy and closeness. The patient obviously wants something from the authoritative doctor. However, from her embodied behaviour, it appears that the patient primarily seeks contact and a dialogical relationship rather than attempting to *communicate* a specific content. Even though she is inhibited from speaking, she could point, or otherwise indicate a communicative need. Rather, she seeks a professional, dialogical relationship by holding the doctor's hand. Holding hands is a dialogical, intimate act that connects individuals and entails moral obligation for caring behaviour (Linell, 2009; Hodges, 2009). Thus language is more than a means for communication:

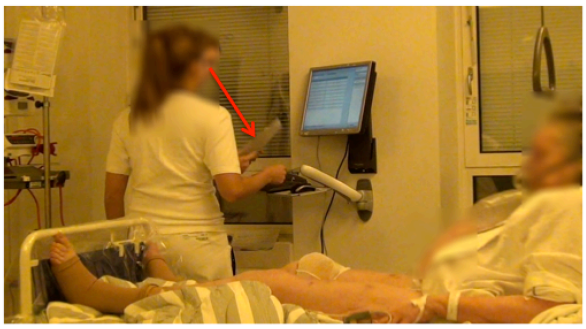
> Roughly put, Saussurian linguistics regarded language primarily as a means of communication. In order to transmit meanings, language employs a more or less fixed code, the features and structures of which can be studied independently. For various strands of literary scholarship and criticism, especially those fostered by hermeneutics, such a perspective on language seemed dangerously one-dimensional. Language was not just or not even primarily a means of communication, but first and foremost the epistemological condition of our existence – the "house of being" (Heidegger). (Benne, in press:78)

If language is an epistemological condition of our existence, then it cannot be reduced to a code distinct from our bodily experiences. *The house of being* involves complex dimensions of human life and experience: engaging in activities with others, touching things etc. are crucial aspects of language. Moreover, the soothing effect of the touch has been demonstrated in other studies. For instance, a neuroscientific study investigated the relationship between stress relief and holding the hand of another person and concluded that: "results indicated a pervasive attenuation of activation in the neural systems supporting emotional and behavioral threat responses when the women held their husband's hand" (Coan et al., 2006:1032). Even though the attenuation of activation in these systems was limited when the test persons held a stranger's hand compared to their husband's hand, the effect was still present. In this case, there is a further incitement for the patient to specifically seek the doctor's attention rather than her husband's: the doctor is the key person in the diagnostic and treatment activity.

Whether the patient wants to be calmed down, needs specific information or something else remains uncertain as the doctor fails to co-act and align with the patient for more than a few seconds. What is certain is that the patient seeks a close rapport with the doctor. At no time is the patient being included in the medical hypotheses generation and when the doctors have finished the examination they continue with hypotheses generation in front of the computer. As the doctors are located around the screen, their backs are towards the patient. The patient then suddenly moves and attempts to sit up in the bed. However, as she raises her upper body the oxygen mask falls off and the doctor of internal medicine immediately reacts by putting the mask back on (see picture F).

Picture F, 12:38:20

Picture G, 12:53:80



Picture H, 13:05:50

The doctors do not interact with the patient but they move the bed so the wire attached to the mask is long enough to allow the patient to sit. The patient sits, but she does not look well, her breathing is troubled and she has a crumpled posture. The doctors leave the patient alone and resume the medical hypothesis generating around the computer (see picture G). After a couple of seconds, the patient falls back in the bed, exhausted and unwilling or unable to say anything (see picture H).

From an observer's perspective, the patient's physical reorganisation does not seem to have anything to do with a wish for sitting up rather than lying down. Rather, it appears to be a wish for integration or communication more generally. Her multiple embodied actions are intentionally directed toward the professionals, but they are not perceived as such by the medical team. As they are fixated on medical problem-solving they do not treat the patient's attempts for dialogue as such.

According to Jensen (2014a:3) emotions are not individual inner states, but "processes of

organism-environment interactions, and given that languaging is seen, not as an abstract semiotic system, but as dynamic adaptive behavior, emotion is to be seen as an intrinsic part of languaging itself." And he continues: "emotions *are* in fact movements; not just within us however, but also movements that connect experiences with situational affordances" (Jensen, 2014a:2ff). The patient's emotional behaviour is identified as a movement of reaching out and an attempt to establish shared coordination that affords dialogue. In the last excerpts, the doctors suppress the emotional dynamics and the patient's movements remain movements. Finally, the patient falls back in the bed and silence or lack of movement is another emotional interactivity trajectory that changes the flow of interactivity from dynamic to static and as mentioned above it harms the patient in the situated interaction: she appears scared and she is excluded from the cognitive system. From a bio-medical perspective no errors are detected, however, from an overall viewpoint the situation seems to harm the patient unnecessarily.

In three interrelated excerpts the patient initiates an emotional relationship with the doctor. The relationship is established through touch in the first two examples, but it lasts shortly and the doctor withdraws and initiates other activities. In the final excerpt the medical team hardly recognises the patient's emotional wish and after having solved the physical constraints for sitting they resume their original task. The medical team is acting to realise only one value: caring for the patient through bio-medical problem-solving. As they focus on the medical aspect of treatment, the emotional side is undermined. In the long run, such a prioritisation could turn out to be a good prioritisation as the patient's life depends on getting the underlying causes for the disease identified. However, as the patient (*a*) perceives the medical team's professional and serious approach, (*b*) has difficulty breathing and (*c*) repeatedly seeks contact, it is likely that she fears for the outcomes of her medical condition. Such feeling calls for alleviation and can be managed if the doctor relies on the team's capabilities for multi-tasking. For instance, in other cases, nurses are called in to comfort the patient and as such caring for the patient in local interaction could be managed if the team distributed responsibility for treatment.

8.2.2 Emotions in a biomedical perspective

This case reflects the tendency that the medical culture builds on a biomedical model that downplays emotional dynamics and prioritises objective medical problem-solving over interpersonal relations when dilemmas arise. Even when, in the second excerpt, the responsibility of task performance is distributed within the medical team, the doctor fails to interact successfully and continues to prioritise the biomedical model. Because the physician of internal medicine functions as the main cogniser (Galosia et al., 2010) during the physical examination task, the doctor has time to follow up on other issues regarding the patient's general situation, but she does not. As a medical team they are able to realise multiple important values simultaneously: caring for the patient and reaching a diagnosis. As they pursue the latter, they overlook the former. The doctor observes the work of the specialist, which inhibits her in adapting to local demands in the patient-doctor relationship, which

again increases the possibilities for human error. The doctor's evasive gaze, her reduced sensitivity to what the patient seeks from her, her fixated attention to the biomedical values on the screen, and the evolving critical situation all afford the doctor to continue as she has done hitherto. The doctor's continuous focus on the medical measurements engages her in abstract cognitive activity, which serves as positive feedback mechanisms as her situation awareness becomes reduced. In the end, this behaviour results in a negative outcome: the patient becomes excluded from the cognitive and dialogical system.

Furthermore, the analysis shows how the biomedical model contributes to the doctor's prioritisation. Even though the situation escalates, the doctor waits (too) long to call for assistance. As the doctor of internal medicine arrives, the doctor does not rely on the cognitive ability of the cognitive system and the system remains unable to realise multiple values. As the biomedical model is prioritised the trajectory is characterised by individual and monological behaviours and it leads to unnecessary consequences: the patient suffers from the lack of coordination.

8.3 Case II: re-enacting role hierarchies

The second case is an example of dealing with joint decision-making in a medical team. An experienced nurse knows which procedure should be initiated but she does not have the authority to decide on this, and the doctor is not immediately convinced that the nurse is right. Thus, experience conflicts with authority, professional roles and responsibility. The negotiation between the two practitioners has an interpersonal, medical and cultural side to it. First, they establish and maintain a respectful interpersonal relation by coordinating gaze and through verbal repair and hesitation. Second, the nurse proves her expertise as she re-enacts her clinical knowledge through bodily movements in a way that plays out the clinical consequences of a decision about to be made. Finally, the nurse speaks with multiple voices (Linell, 2009) as she integrates the general practice in the actual situation with the two practitioners. By so doing, it underlines the importance of silent others (Linell, 2009), culture and norms as constraints in real-time interactivity, and it shows how decisions are not about individual cognition but enabled by dialogical coordination *in situ* and over time. Specifically, this will be shown in great detail by presenting a cognitive event trajectory with multiple event pivots that contribute to the end result, namely the final decision about which procedure will be initiated.

The medical team consists of an experienced nurse and a novice doctor who has worked at the ward for only a couple of days when the recordings took place. The patient is a 92 years old lady who arrived with a hip fracture caused by a fall. As we enter the situation, the patient is suspected of having sustained proximal femur fractures, and it is later shown that the patient indeed *has* a broken hip. An overview of the setting is given below:

Figure 8.4: Overview of the layout: embodied procedures

8.3.1 When the nurse knows what to do, but eventually works against her own solution

During the pre-treatment, the patient suddenly utters a concern related to the diaper she is wearing. The nurse responds with the suggestion that they should probably insert a catheter on the patient. This was not part of the doctor's plan and it leads to a process where both medical and interpersonal issues are at stake:

Transcript 8.1
Duration: 01:01:00 minutes

DANISH ORIGINAL

```
1.  34:01:10, P:   jeg har s jeg har sådan en (.) ble p[å
2.  34:03:50, D:                                         [ja:: det har du
3.  34:04:60, P:   ja
4.  34:05:00, ps.  (0.8)
5.  34:05:80, D:   øhm
6.  34:06:40, ps.  (0.7)
7.  34:07:10, N:   vi skulle jo nok lægge et kateter
8.  34:08:60, ps.  (0.9)
9.  34:09:50, D:   ska vi det (.)
```

10. 34:10:20, N: eller (.) det er ikke nødvendigt måske
11. 34:12:30, P: (xxx) [det det det næ det plejer jeg [ikke
12. 34:12:60, D: [na:rj det er da ikke nødvendigt hvis ikke du plejer at bruge kateter
13. 34:15:30, N: [nej jeg tænker nogen gange med mobilisering til bækken og sådan noget men det kan vi jo nok godt↓
14. 34:19:20, ps. (0.7)
15. 34:19:90, N: få et bækken ind under når du skal tisse og sådan↑
16. 34:22:80, P: ja [det ved jeg
17. 34:23:10, N: [men det virker som du er rimelig god alligevel til og lige at få
18. 34:26:40, ps: (0.8)
19. 34:27:20, P: ja bortset fra at øh den der den gør ondt
20. 34:30:30, N: ja:=
21. 34:30:70, D: =men nu lægger jeg jo FIC-blokken
22. 34:31:80, N: ja
23. 34:32:40, D: tror du tror du ikke vi klarer [°°uden°°
24. 34:33:80, N: [vi gør det jo tit men men men lad os bare prøve at se
25. 34:36:60, D: ja det ved jeg ik så [det det er jo det kan da godt være vi [ska det er dig øh
26. 34:37:40, N: [ja
27. 34:38:40, N: [ja men det er jo folk der [ik øh ka:: ka bevæge sig så godt og jeg synes egentlig hun er rigtig god
28. 34:40:20, P: [altså jeg har jeg har jeg har den der på gulvet med min mave
29. 34:45:20, D: med maven [der driller den er [lidt tynd (.) ja
30. 34:45:80, P: [ja [ja ja
31. 34:48:20, N: lad os bare lige øh (.) nu prøver vi bare li:ge at lægge det her så
32. 34:50:80, D: e ellers det [jeg tror det er dig de::r er me::st øh
33. 34:51:30, N: [ja jeg tror nemlig (0.1) ja (0.1) vi ser det lige an (0.3) fordi jeg synes egentlig også at øh det er realistisk og
34. 34:57:90, D: det er jo begrænset hvor mange bækkener jeg lægger
35. 35:00:10, P: ja
36. 35:00:70, D: eller hvad hedder det
37. 35:01:30, N: ja (smiling)
38. 35:01:70, D: så (laughs)

ENGLISH TRANSLATION

1. 34:01:10, P: I have a I have such a (.) diaper o[n
2. 34:03:50, D: [ye::s you have
3. 34:04:60, P: yes
4. 34:05:00, ps. (0.8)
5. 34:05:80, D: ehm
6. 34:06:40, ps. (0.7)
7. 34:07:10, N: we should probably insert a catheter
8. 34:08:60, ps. (0.9)
9. 34:09:50, D: we should (.)
10. 34:10:20, N: or (.) that is not necessary perhaps
11. 34:12:30, P: (xxx) [that that that no: I do [not
12. 34:12:60, D: [no:: that should not be necessary if you do not

		ususally use a catheter
13.	34:15:30, N:	[no I think sometimes with regards to the mobilisation to the bedpan and such but I guess we can manage that↓
14.	34:19:20, ps.	(0.7)
15.	34:19:90, N:	place a bedpan under when you need to go to the toilet and such↑
16.	34:22:80, P:	yes [I don't know
17.	34:23:10, N:	[but it seems like you are pretty good anyway to just get
18.	34:26:40, ps:	(0.8)
19.	34:27:20, P:	yes except from ehm that this one it hurts
20.	34:30:30, N:	ye:s=
21.	34:30:70, D:	=but now I am going to perform the FIC blockade right
22.	34:31:80, N:	yes
23.	34:32:40, D:	don't you don't you think we manage [°°without°°
24.	34:33:80, N:	[we often do it but let us just try and see
25.	34:36:60, D:	yes that I do not know so [it it is well it might be that we [should that is you eh
26.	34:37:40, N:	[yes
27.	34:38:40, N:	[yes but that is people who are [unable eh to move so easily and I actually think she is really mobile
28.	34:40:20, P:	[well I have I have I have this one on the floor
29.	34:45:20, D:	with the stomach [that is a bit tricky it is [a bit diarrhoea like (.) yes
30.	34:45:80, P:	[yes [yes yes
31.	34:48:20, N:	let us just eh (.) now we are ju:st trying to give this so
32.	34:50:80, D:	o or this [I think it is you who a::re the mo::st eh
33.	34:51:30, N:	[yes because I believe (0.1) yes (0.1) we will just wait and see (0.3) because I actually also think that eh it is realistic and
34.	34:57:90, D:	after all I only place a limited number of bedpans
35.	35:00:10, P:	yes
36.	35:00:70, D:	or what is it called
37.	35:01:30, N:	yes (smiling)
38.	35:01:70, D:	so (laughs)

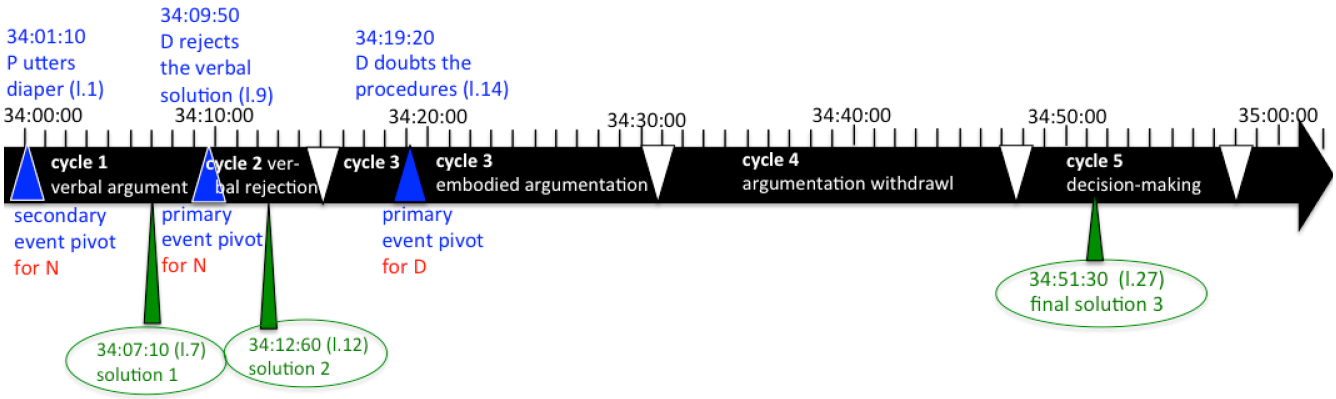


Figure 8.5: Embodied narratives in decision-making

Figure 8.5 shows 5 phases in the cognitive event trajectory. In total it illustrates how a cognitive result is enabled by multiple enacted and embodied strategies that link non-local experience and cultural dynamics with local coordination and negotiation.

During the pre-treatment, the patient mentions that she is wearing a diaper (line 1). This utterance is identified as the event pivot that prompts the nurse to interrupt the current practice (see figure 8.5). Her interruption leads to a discussion about procedures and it has consequences for the patient's treatment process. Only 6 seconds later (34:07:10), the nurse suggests - based on the patient's impulse - that the proper solution to an anticipated problem of urination is to insert a catheter soon (cycle 1 in figure 8.5). When she proposes this she gazes at the patient's body. Just at the end of her utterance she gazes at the doctor. A pause of 0.9 seconds follows (line 8) before the doctor questions the suggestion directly (line 9) when the two practitioners have direct eye contact.

Much in emergency diagnosis is about estimation, hypothesis generation and interpretation. In this case, to insert a catheter is not a rule, but a judgement based on how mobile the patient is. Thus, as the doctor utters: *we should* (line 9), it does not refer to any rules that need to be followed, but to whether it is necessary action and as such she questions the proposal held by the nurse. The misgiving further indicates that this strategy was not part of the doctor's plan for pre-treatment. Interpersonally, the two have started a negotiation that needs to balance both a clinical aspect as well as their respective professional roles. The doctor's doubts are identified as the primary event pivot for the nurse that leads to a withdrawal in order to maintain face but it also leads to a different and more powerful argumentation strategy.

Thus, the nurse hesitates *or (.)* before she modulates her proposal into a question: *that is not necessary perhaps* (line 10). While the nurse initially proposed a procedure, she now asks the doctor whether this is a good idea and it marks herself as the inferior in the role hierarchy.

The patient utters something inaudible (line 11), and the doctor interrupts her and deals with the nurse's question by using the patient as a cognitive resource in hypothesis testing and a person with a right to have opinions*: no:: that should not be necessary if you do not usually use a catheter*. The patient now becomes a vibrant part of the cognitive system, and as the doctor addresses the patient with the deictic 'you' she changes her orientation (in gaze, body position and in verbal utterance) from the nurse towards the patient. The nurse keeps looking at the doctor, who is going to decide what to do and as such the cognitive system is a triadic configuration maintained through coordinated gaze and a cognitive problem. The doctor keeps gazing at the patient who provides an answer to the doctor's question. As the patient's answer confirms the doctor's presumptions it implicitly implies that they should follow the doctor's original plan for treatment. Interpersonally, the inclusion of the patient enables the doctor to turn down the nurse's suggestion in a more implicit and caring fashion, since she avoids a direct confrontation and individual rejection. In the figure, this process is characterised as a temporarily rejection (cycle 2 in the figure). Medically, however, the answer to whether the patient needs a catheter or not, is *not* a question of whether the patient normally uses catheter. Rather, it is about her present

condition (a broken hip) that might complicate or even prevent the patient from going to the toilet. In that sense, including the patient as a cognitive element in the decision-making process does not contribute any valuable cognitive insight regarding the clinical problem that needs to be solved.

It is the doctor who is responsible for the treatment and in the end she has the authority to decide what to do. Offhand, it seems as if a new decision is reached in line 11-12. However, the nurse interrupts the patient and she uses another strategy than previously. This is visualised as cycle 3 in the figure 8.5. First, the nurse disagrees: *no* (line 13) and she immediately elaborates her line of argumentation by referring to general practice: *sometimes* (line 13). Second, she anticipates the line of actions in the case that the patient needs to go to the toilet. This anticipation is articulated in a precise whole-bodied narrative of how the bedpan is *sometimes* difficult to mobilise. As she refers to previous situations *sometimes with regards to the mobilisation* (line 13) she uses her body to visualise the physical constraints in placing a bedpan under the patient (see figure 8.6 below).

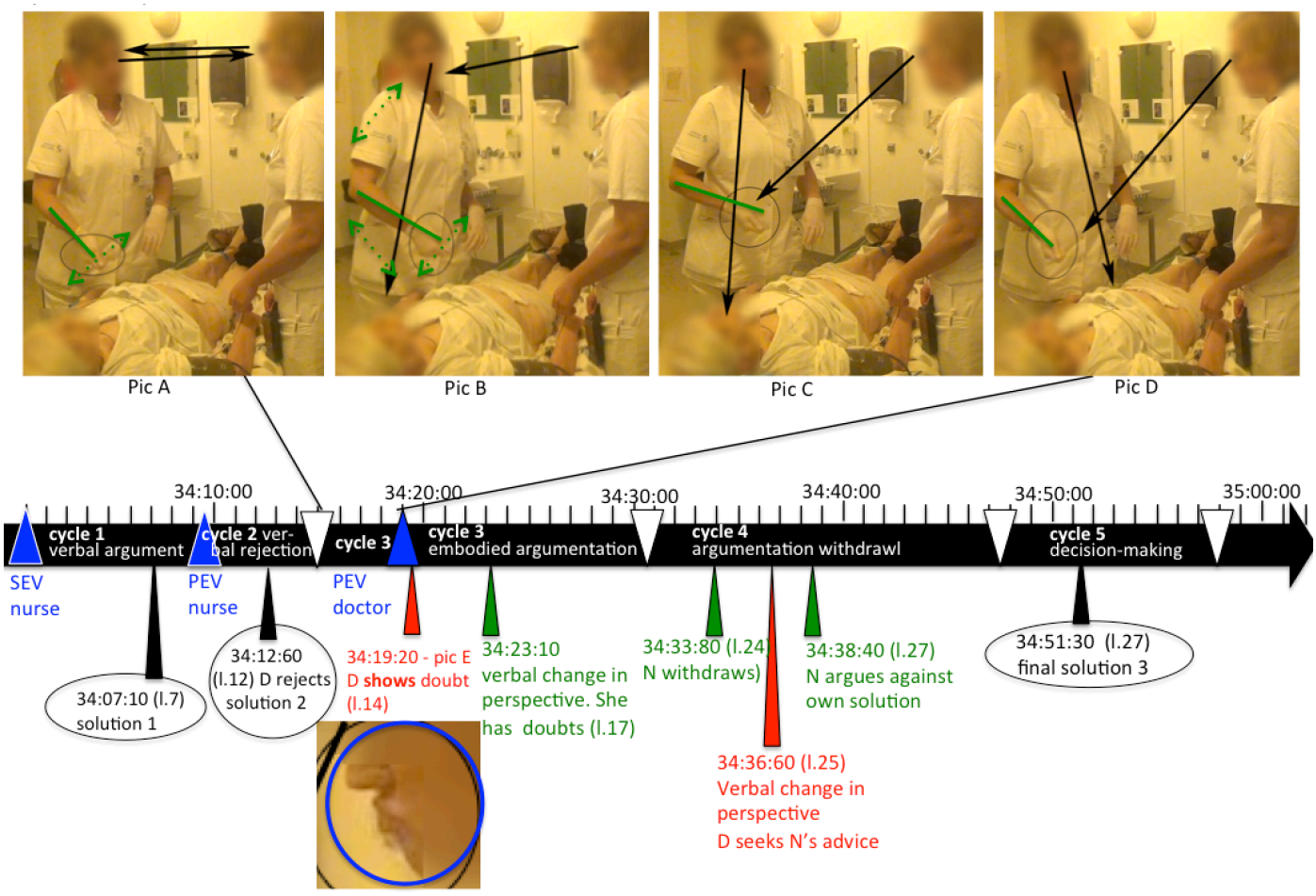


Figure 8.6: Elaborated version of figure 8.5

**In picture A-D, the nurse wiggles her hips and torso from side to side as she moves her left hand back and forth. These body movements visualise the physical constraint when arranging a bedpan. Simultaneously, the nurse utters: [no I think sometimes with the mobilisation to the bedpan and such, line 13.*

She plays out the situation for both the doctor that needs to be convinced and make the final decision and the patient who will feel the consequences of the decision (see figure 8.6). 0.2 seconds before (34:15:10) the nurse utters her concern of placing a bedpan, she initiates a series of embodied movements that prove to be crucial in the doctor's change of perspective. As the nurse verbally explains the process of placing the bedpan (line 13), she wiggles her hips and upper body from side to side as she moves her right arm back and forth to simulate the actual bodily movements required in order to locate a bedpan properly (see figure 8.6). As the nurse wiggles her hips she simulates the movements of the patient during the location of the bedpan. However, the back and forth hand movements visualise the physically gentle movements performed by the healthcare practitioners when placing a bedpan. As such the nurse communicate the bio-emotional consequences for the patient and the constrained working conditions for the practitioners. In picture A and B the doctor gazes at the nurse's head but she soon turns her attention to the movements that the nurse performs (picture C and D).

During the narrative the doctor carefully observes how the nurse plays out the scenario through embodied movements. When the nurse has demonstrated the problem, she stops moving her body and dampens her concern. At 34:18:10, the nurse acknowledges that they (the doctor and herself) probably *are* capable of mobilising the bedpan: *but I guess we can manage it*↓ (line 13) as she nods 'yes' and gazes at the doctor. The doctor hesitates (a pause of 0.7 seconds emerges) as she makes a noticeably facial expression that resembles a kind of lip-pursing grimace response (see picture E in figure 8.6). Thus, the doctor does not respond verbally, but she wrinkles her nose and pouts her lips in a remarkable way, which indicates a concern of *some kind*.

The nurse re-enacts her knowledge in situ. Her embodied historicity empowers her to visualise and demonstrate the actual implications, and it enables her to anticipate common practice in a powerful and convincing way. The embodied knowledge of the nurse turns out to be an important element for the doctor to change her mind regarding pre-treatment. While the doctor does not respond directly to her implicit question, the nurse continues the dialogue. She now directs herself towards the patient and she implicitly invites the patient to share her opinion on the matter by shifting perspective from the doctor-nurse relation *we* (line 13), to the patient *you* (line 15). She adds: *place a bedpan under when you need to go to the toilet and such* (line 15). As she utters this, she briefly simulates how she as a nurse would place the bedpan under the patient. Obviously, to wiggle one's hip and torso is not a preferable activity if your hip is broken. The patient does not have the medical expertise to decide whether this is achievable or not, but the nurse's anticipatory bodily visualisation has a strong illustrative power that enables the patient to imagine the situation in a detailed and tangible way beyond verbal explanations. Thus, the nurse's whole-bodied expression prompts the patient to utter her doubt about whether this is doable or not (line 16). However, the nurse now links her embodied expertise with situational information and she compares general cases with the contextual patient: *but it seems like you are pretty good anyway to just get* (line 16) as she simulates the future movements of the patient.

The dialogue so far has made the nurse unsure of her own suggestion, the doctor seems

puzzled (see picture E) and the patient is now insecure. The patient does confirm the nurse's interpretation of her physical condition, and adds that her hip hurts (line 19).

The doctor then comes up with a final counterargument and in figure 8.5 and 8.6 this is characterised as the fourth cycle of argumentation. As the doctor will soon be giving the patient anaesthetic, she asks the nurse if she agrees that this will be sufficient action and that they (*we)* will be fine with that solution (line 23). This is the first time the doctor verbally hesitates: *don't you don't you* (line 23). The nurse's reply is ambiguous. On the one hand she refers to traditional work procedures at the ward: *we often do it* (line 24). Further, by using the pronoun *we* she re-enacts the general team of professionals (cf. Linell, 2009) who often choose to insert a catheter. This is a way to strengthen her individual thoughts *in situ* by drawing on experience and general practice. Hollan et al. (2000:178) elaborate that on the one hand:

> culture emerges out of the activity of human agents in their historical contexts, as mental, material and social structures interact, and on the other hand, that culture in the form of a history of material artifacts and social practices, shapes cognitive processes, particularly cognitive processes that are distributed over agents, artifacts, and environments. […] Culture is a process that accumulates partial solutions to frequently encountered problems. Without this residue of previous activity, we would all have to find solutions from scratch. We could not build on the success of others. […] This is tremendously enabling. But it is not without cost. For culture may also blind us to other ways of thinking, leading us to believe that certain things are impossible when in fact they are possible when viewed differently.

In that sense, the power of culture is re-enacted through multiple voices (Linell, 2009) in interactivity as she performs beyond a level of individual authority. The nurse indicates how general practice works and how experienced colleagues complete a specific work procedure. On the other hand, she immediately downplays the importance of 'usual business' by now supporting what initially was the inexperienced doctor's plan: *but let us just try and see* (line 24). The nurse is not the only one who seems to be changing her mind (see figure 8.6). The doctor now states in a rather incoherent way that she does not know what is the best decision, and shortly after the doctor explicitly refers to the nurse as the expert: *o or this [I think it is you who a::re the mo::st eh* (line 32) and she puts herself in a position of the less experienced practitioner regarding this matter. However the last cycle 5 is where the nurse concludes: *let us just eh (.) now we are ju:st trying to give this so* (line 31). During this event, multiple suggestions have been evaluated within the team and confusion emerges. The nurse, thus, contributes to the final cognitive results as she makes clear what they will do: *we will just wait and see (0.3) because I actually think that eh it is realistic and* (line 33, see figure 8.6).

Immediately after the nurse has reached the conclusion, the doctor turns to the patient and utters that she usually deals with other tasks: *after all I only place a limited number of bedpans* (line 34). This explanation serves as a logical excuse for her lack of expertise and as such it secures the maintenance of her face to the patient (Goffman, 1959).

At 35:00:00, the end of line 33, a decision is reached. The cognitive result is the outcome

of 42.20 seconds of interaction. But how is the decision made? Who made it? And what are the enabling conditions for decision-making? From figure 8.5 and 8.6 it appears that the process of decision-making is empowered by coaction rather than individual information processing. The practitioners' coordinated interactivity is a process of meshing experiences, medical expertise and situational dynamics. Even though insecurity, confusion and even frustration emerge in the system, such states are results of a dialogical interaction based on respect and expertise. However, as the two elements contrast, the decision-making is achieved by balancing these in a respectful interaction. This is elaborated below.

The nurse has richer experience but lower authority, and the two practitioners need to co-act to come up with the best solution. We witness how sense-making of other colleagues affects the sense-making of the doctor, and how previous situations shape real-time decision-making. The nurse initially provides a plan for further actions. However from line 13-33 she is involved in a process of doubt that eventually leads to a contradictory plan. The nurse's argumentation is ambiguous; on the one hand she argues that they usually initiate the procedure, the doctor initially argues against, and as such, she draws on the cultural dynamics and normative procedures to support her proposal. On the other hand, when the doctor invites the nurse to take part in the decision-making, the nurse argues against her own proposal and uses the local situation as a counter argument to why they should *not* insert a catheter. The nurse's logical explanation is that the patient appears mobile and flexible and the insertion of a catheter is only standard procedure in cases of less mobile patients.

Even though the nurse takes control in some sense, she puts herself in a non-expert position by withdrawing her own proposal and deciding to do what the doctor initially argued. So why does this happen? Why does the nurse change her mind? From a purely clinical point of view the decision is not based on best practice and expertise but on interpersonal caring and an orientation to hierarchies and practices for decision-making. The case demonstrates that in real-life situations decisions are not made in a vacuum and interpersonal relations are shaped through the processes of maintaining each other's face (Goffman, 1959) and orient to role hierarchies that exist between the different positions (Pedersen, 2010). To begin with, the doctor challenges the nurse and questions her suggestions. Interestingly, however, in the end it is mainly the nurse that maintains and supports a fixed role hierarchy, with the doctor at the top. What she knows is suddenly neglected and she herself contributes to the strengthening of a fixed role hierarchy, which the department is explicitly seeking to overcome. However, at an overall level, it is difficult to identify who made the decision. We can say that the nurse finally argued to wait and see what happens (line 33). Yet, in the end, no one is in charge and neither dares to put their neck out and take responsibility. In figure 8.5 and 8.6, multiple pivots indicate the shaping of cognitive processes. For instance, the nurse's embodied simulations contribute to the process; the doctor's inclusion of the patient; the explication of

conventional procedures; the rational evaluation of the FIC block[30] effect; gaze and gestures are all factors that the practitioners jointly enact, and together these aspects contribute to the cognitive result. The fact that only one person explicitly utters the solution does not mean that the cognitive work towards the outcome is only individually exercised.

A few hours after the recordings, I interviewed the doctor, who told me that the nurse was right. It had not been possible to mobilise the bedpan under the patient. This caused a delay in the treatment plan, and it harmed the patient unnecessarily. When the doctor was asked to elaborate what she believed went well and not so well in the process, she stated: "*It went okay, I think. Good contact and the trust was there*." According to the doctor the thing that went less well was, that they were wrong and have had to insert the catheter at a later and more complicated stage in the treatment process. However, the doctor further emphasised: "*as the nurse also said,*" which indicates that the doctor was wrong and the nurse right. Thus the doctor did not experience the situation as shared decision-making with equally shared responsibility for the decision that they reached. This corresponds to Leape's description of how errors are related to guilt and individual blame rather than learning: "errors are regarded as someone's fault, caused by a lack of sufficient attention or, worse, lack of caring enough to make sure you are correct […] usually a "human error", the causes of that error are often well beyond the individual's control" (Leape, 1994:1852). At one point it makes sense to argue that the nurse knew what to do, but in the end she was also the one that pushed the decision in the opposite direction. In the interview, the doctor's experience of their team performance does not match the actual coordination shown in the data. Rather, from the data I identified multiple event pivots that, in the end, indicate a change of perspective in the doctor's goal orientation. They hypothesise various scenarios and the doctor is finally convinced that the nurse has valuable expertise due to her greater experience with similar cases: *I think it is you who a::re the mo::st eh* (line 32), and due to the qualitative and particular experience with the task that is usually a nurse's job task: *after all I only place a limited number of bedpans* (line 34).

The nurse, on the other hand, commented during the interview that the collaboration went well, however, as it is usually the case, the doctor had not listened carefully to what she as a nurse had to say. Paradoxically, both the doctor and the nurse reach the same conclusion about responsibility, but it does not conform to what the data shows. Initially, the doctor rejected the nurse's proposal, but that changed as the nurse enlightened the doctor about possible future complications. In the end, the nurse did not listen carefully to the doctor's concerns.

From figure 8.5 and 8.6 it is noticeable that the team performs as one cognitive system that seeks to balance multiple values to maintain the system's boundaries. By investigating the overall event trajectory, neither of the practitioners made the decision individually. Rather, the system's coordination is saturated by (*a*) the nurse's non-local experiences of

[30] FIC-block is an abbreviation of *facia iliaca block* (femoral nerve block).

clinical procedures, (*b*) the medical team's knowledge of non-local expectations about how decision-making is managed (role hierarchies etc.) and (*c*) situational affordances for valuable actions: the patient's viewpoint and attitude. The decision (the result) is the product of interactivity. Crucial to a team's general successfulness is the ability to care for both the people in interaction (patient, colleagues and oneself) and the task to be solved (diagnosis, examination and treatment). In this case, the team balances procedure and interpersonal dynamics, and it shows that keeping each other's face is important in diagnostic situations. However, as they become too focused on professional caring, they fail to make the best decision for the patient.

The practitioners' actions reflect embodied cultural understandings of multiple conditions as for instance role hierarchies, norms for working, systemic and physical limitations, fixed procedures, personal experience, and caring for human beings embedded in complex situations. If practice is to be changed, none of these cultural parameters can be ignored. Values guide the selection of goals and procedures, and are the basis for organising and revising these goals and procedures as we learn from experience. A values realising perspective (Hodges and Baron, 1992) works against an exclusive focus on goal seeking, rule following and rigid hierarchical decision-making structures. By using Hodges and Baron's (1992) notion of value heterarchy, it becomes possible to think of roles in terms of a *role heterarchy* instead of a traditional *role hierarchy* (Pedersen, 2010; 2012).

Finally, an ecological perspective on cognition reveals how cultural dynamics affect local decision-making. In this case I showed how such dynamics are re-enacted not by wordings or procedures alone, but by whole-bodied coaction. Culture, is not about individual choices, but it is constantly re-enacted as an emergent phenomenon: what individuals say and do together *in situ*.

8.4 Conclusion: breaking down traditions

In the first case, the doctor is fixated on medical measurements on the screen as she struggles with diagnostic hypotheses generation and this behaviour leads to a constrained situational sensitivity to local changes within the patient domain. With Martina et al., (2014) this lack of situational awareness and ability to build good rapport with the patient is partly due to an incomprehensive teaching practice:

> Although nonverbal communication is addressed in many medical school curricula, the focus tends to be on body language and use of gestures rather than the intimacy of touch. Yet physical examination is a dynamic process of engagement. For example, as we examine a patient, we perceive on multiple levels—not just the presence or absence of physical signs, but also the patient's comfort and emotional state. In turn, the patient responds to us—reading our facial expressions, interpreting the pressure of our fingertips, and responding to the gentleness (or lack thereof) to inform how he or she will proceed within the consultation. (Martina et al., 2014:1314)

Verghese (2008) argues that medical students must learn how to use clinical skills at the

bedside with real patients and by observing master clinicians. Moreover, he claims, such a dialogical approach will bring about cultural change and nourish one's sensitivity and perceptual system to identify local relevant dynamics (Verghese, 2008). As such, the relationship between healthcare practitioner and patient becomes more bodily, more caring and more situated and it can be balanced with the biomedical model and demands for providing clear diagnoses. The doctor is further constrained by sociocultural norms and procedures – originating from the bio-medical model – to separate and prioritise medical calculation over emotional and interpersonal relationships. In this case, the doctor is rather confident in using self-initiated touch to calm the patient down in the examination process. However, when the patient touches the doctor, she withdraws and leaves the patient in an emotionally distressed state.

The second case investigated the complexity and constraints of cultural dynamics in local interaction. Specifically, the analyses show how culture with a constant focus on local errors and individual blame pervades local treatments activities without anyone being fully aware of it. It leads to the hypothesis that many failures and errors are never identified for what they really are if self-reports or complaints are the mechanisms used to detect such processes. This is why observations of real-life situations are vital if learning is to be achieved.

By emphasising the value of an ecological approach, decision-making is not an individual, mental task, but a shared process with shared responsibility maintained through coaction. This viewpoint is far from how practitioners experience what they do and how decisions are made in real-time.

To establish an interpersonal relationship based on co-presence and attention, participants need to co-ordinate priorities. Collective and effective coordinated problem-solving thus depends on sharing and caring. When these values are not present, felt, or shown, distributed cognition is to some extent dysfunctional. In the first case, the doctor does not share her concerns explicitly, thus lack of coordination is the result. In the second case, the nurse is a moral being that fails to balance different tasks and values in the system because she relies too much on one value (caring for the doctor's face). The team coordination entails the establishment of a frozen role hierarchy that serves as a constraint and hindrance for adaptive flexible behaviour. *When medical teams believe in role hierarchies, they become real in their consequences,*[31] which means that when cultural dynamics are automatically re-enacted in local interaction, they serve as feedback mechanisms in that particular situation. Positive feedback mechanisms emerge in interactivity imbued with latent conditions for human error. In this case, experiences of how role hierarchies shape action patterns become a positive feedback mechanism that nourishes that specific expectation and inhibits a flexible orientation to local situational dynamics.

To conclude, this chapter points to the importance of investigating what is beyond the

[31] Paraphrasing The Thomas theorem: "when men define situations as real, they become real in their consequences" (Thomas and Thomas, 1928:571-572).

micro-sociological scale of conversation. The way healthcare practitioners generate cognitive results is characterised by enacting embodied experience, sociocultural norms and situational dynamics.

9. Sense-making teams and expertise: an educational perspective

9.1 Why study teams?

This chapter investigates how teams make sense. It pays attention to the benefits of thinking of a team as a cognitive system with sense-making qualities different from those of individuals. As mentioned in chapter 1, human errors are frequently related to a perceived lack of communication and coordination. This problem has given rise to an interest in studying this phenomenon further, thus, over the last decades there has been an increasing interest in conversational issues in healthcare. Communication skills such as team performance (e.g. Grumbach and Bodenheimer, 2004; Manser et al. 2009; Manser, 2009; Husebø et al. 2011) have been implemented in healthcare practices in order to train practitioners in safe and efficient patient care. There is an overwhelming literature on teamwork and communication skills (e.g. Senge, 2006; DuBrin, 2004; Glaser, 1994), but it primarily pays attention to individuals within the team. Much is left out, when the objective of analysis is solely individual action rather than the cognitive system, no matter its size (Hollan et al, 2000). Furthermore, Paradis et al. (2014) argue in a recent review on insights provided by qualitative studies of interprofessional care delivery in intensive care that "the fundamental insight that interprofessional interactions in intensive care do not happen in a historical, social, and technological vacuum must be brought to bear on future research in intensive care if patient safety and quality of care are to be improved" (Paradis, 2014: 230). And Hindmarsch and Pilnick argue that:

> despite the wealth of studies of health-care teams and medical practice, we are left with little understanding of the skills that enable medical staff to come together for a duration of an operation and coordinate their work such that they are seen as professionals: competent in the practices that form the foundation to this community. (Hindmarsch and Pilnick, 2002:141)

The literature focuses on organisationally prescribed team constellations in order to scaffold individual patient care programs etc. (Hindmarsh and Pilnick, 2002). However, in emergency wards teams are ad hoc constellations, rather than stable assemblages. In such

cases, the focus is not: "to decide on patient care removed from the presence of the patient, but to coordinate their contributions to actual care work in situ, in the moment, and with the patient" (Hindmarsh and Pilnick, 2002:140). When ad hoc teams emerge multiple issues are at stake. For instance, the level of expertise, the knowledge about medical equipment, the interpersonal relationships amongst some team members, and the presence of bystanders (for instance medical students) are all constraints within which "the team has to build enough rapport to be able to manage the health and safety of the patients under their care. Indeed, their ability to collaborate successfully is critical and can significantly affect the quality of patient care" (Hindmarsh and Pilnick, 2002:141).

Managing cognitive events in emergency medical teams is difficult, both due to how such teams are constituted, and because of the problems they face. Emergency medical teams are led by medical practitioners who have to deal with presentations of sometimes highly ambiguous symptoms, incomplete information, and a high degree of specialisation of the team's members. In terms of organisational literature, emergency medical teams are "fluid teams" (Edmondson, 2012) whose 'teaming' depends on gathering experts into temporary groups "to solve problems they're encountering for the first and perhaps only time" (Edmondson, 2012: 74). Edmondson (2012:74) elaborates: "Think of clinicians in an emergency room, who convene quickly to solve a specific patient problem and then move on to address other cases with different colleagues, compared with a surgical team that performs the same procedure under highly controlled conditions day after day."

Given these conditions, the educational challenge for a department of emergency medicine is daunting: faced with patient narratives and symptoms that differ from textbook diagnoses and descriptions of diseases, medical novices have to become experts capable of making critical decisions while managing fluid teams in an unpredictable clinical context. Furthermore, the fact that different areas of responsibility are tied to specific formal roles entails expectations for certain role hierarchies. However, as is often the case in emergency departments, the majority of doctors are novices that work with experienced nurses, a constellation that might lead to frictions and tensions within the team, see chapter 8.3.1. Thus, medical practitioners also need knowledge of *how* medical teams function, *how* practitioners interact, and *how* to develop the skills required. Rather than emphasise medical knowledge, this chapter therefore examines the management of real-time cognitive events in the emergency medical team. The team's expertise depends on subtle modes of coordination that may be especially important in emergency settings where medical teams face unpredictable cases, unpredictable resources, time-pressure and the pressure to make critical decisions quickly and determinedly.

This chapter investigates two cases with ephemeral and unique teamwork constellations. The first case shows how such a team constellation is a possibility to engage in ongoing interactivity and test common procedures in the ward in a way that scaffolds learning. By showing how cognitive insights depend on the ability to embed and link the slow, non-local narratives in fast real-time dynamics, the term expertise extends to involve more than individual mental activity and embodied skills: expertise depends on historical agents that draw on interactivity.

The second case demonstrates the benefits and efficiency of organising work procedures within a team. Specifically, it shows how recalibrating the boundaries of the cognitive system coordinates teamwork *with* and *without* the patient and how different members within the team perceive changes in the layout of affordances differently. It pivots on how habit and expertise are required by linking a team's perceptual capabilities with an individual's own experience. Showing how negative feedback mechanisms contribute to a team's functional coordinative behaviour and joint sense-making, gives an understanding of the possible benefits such a composition imparts on practical cognition. If an emergency ward works with an anticipatory approach to human errors, it can arrange work practices in accord with such insights to stimulate teamwork and increase chances for effective and dialogical outcomes.

9.2 Case I: finding problems to solutions

The following excerpt derives from the same treatment situation as the final case in chapter 8 where a doctor and a nurse discussed whether they should insert a catheter or not, but it takes place later on in the diagnostic process. The novice doctor and the experienced nurse constitute a functional team where a specific, trivial work procedure - the performance of a femoral nerve block (FIC-block) - becomes the basis for learning. After the patient has been informed about the pre-treatment process and the procedure has been explained to her, few procedural steps are required: First, the doctor needs to identify (via palpation) and mark (usually by pen) the needle insertion site. Second, the skin area must be disinfected before the doctor is able to insert the needle. Third, she performs the FIC block. Under normal circumstances, the third step causes latent or light troubles, because the marking (first procedural step) is made by pen and the ink often disappears when it is cleaned with alcohol (second procedural step). As a consequence of this challenge the doctor needs to, in standard situations, allocate a lot of cognitive effort to memorise exactly where the mark was in the first place when the third procedural step is executed. In this excerpt, the doctor has completed the first two steps and she is about to insert the needle. The nurse stands by and is ready to assist if any complications occur, see below.

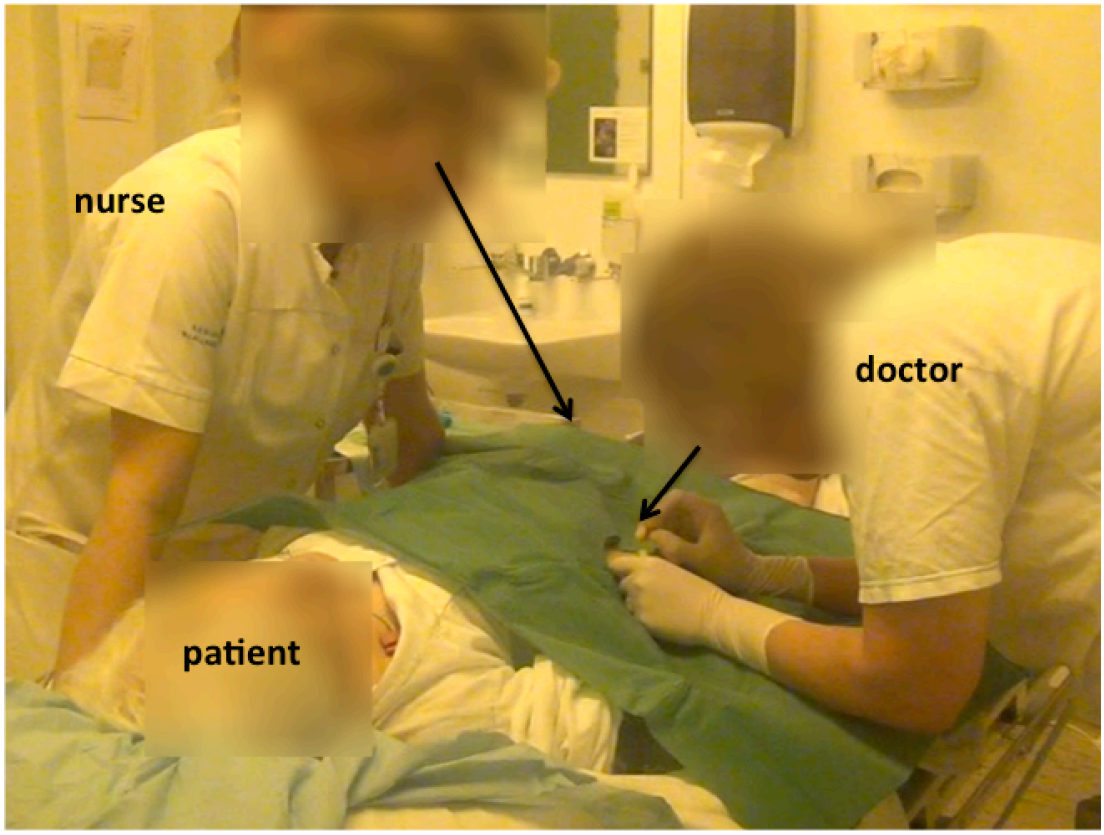


Figure 9.1: Overview of the layout: problem finding

The nurse's task is to assist the doctor if any complications emerge, thus she carefully observes the work of the doctor. During this process, the nurse perceives an unfamiliar work procedure and she expresses an interest in the alternative method that the novice doctor uses:

Transcript 9.1
Duration: 00:04:70 + 00:20:10. Total: 00:24:80 seconds.

DANISH ORIGINAL

```
1.  43:52:00, N:   har du lavet sådan en afmærkning i huden
2.  43:54:10, ps.  (0.5)
3.  43:54:60, D:   ja: kan du se det
4.  43:55:50, N:   ja (.) hvordan har du gjort det
[…](25.5) [The patient complaints about pains in her hip]
5.  44:22:40, N:   men øh hvad har du lavet den der afmærkning med
6.  44:25:10, D:   jeg har taget en øh prop fra ø:h de der saltvandssprøjter
7.  44:27:80, ps.  (1.2)
8.  44:29:00, N:   okay
9.  44:29:20, ps.  (1.5)
10. 44:30:70, N:   det var ret smart
11. 44:31:20, ps.  (0.8)
12. 44:32:00, D:   ja men fordi [ellers så forsvind (.) narj men det er fordi
```

```
                  eller så forsvinder det jo når man tegner det med kuglepen ik
13. 44:32:40, N:                [det tror jeg aldrig jeg har set før
14. 44:36:50, ps. (0.8)
15. 44:37:30, N:  ja når du vasker a[f
16. 44:38:10, D:                    [når jeg vasker af ik
17. 44:38:90, N:  ja
18. 44:39:30, D:  så øh (.) nu skal du se så er det denne her jeg kommer ned så
19. 44:40:60, N:  det har jeg nemlig os (.) tit tænkt på
```

ENGLISH TRANSLATION

```
1.  43:52:00, N:  did you make such a mark in the skin
2.  43:54:10, ps. (0.5)
3.  43:54:60, D:  ye:s do you see that
4.  43:55:50, N:  yes (.) how did you make it
[…](25.5) [The patient complaints about pains in her hip]
5.  44:22:40, N:  but eh with what did you make that mark there
6.  44:25:10, D:  I took a eh a plug from e:h those saline needles
7.  44:27:80, ps. (1.2)
8.  44:29:00, N:  okay
9.  44:29:20, ps. (1.5)
10. 44:30:70, N:  that was pretty clever
11. 44:31:20, ps. (0.8)
12. 44:32:00, D:  yes but because [otherwise they disap (.) no: but it is
                  because otherwise it disappears you see when you draw with a
                  pen right
13. 44:32:40, N:                  [I do not think I have ever seen that before
14. 44:36:50, ps. (0.8)
15. 44:37:30, N:  yes when you wash it o[f
16. 44:38:10, D:                        [when I wash it off right
17. 44:38:90, N:  yes
18. 44:39:30, D:  so eh (.) now you will see then it is this one I put down so
19. 44:40:60, N:  I have actually also (.) often thought about that
```

The doctor has made a mark in the patient's skin in a way that is new to the nurse. As the nurse perceives this, she is still unaware that the mark is a *solution* to a relevant problem or challenge in the ward. Intrigued by the mark's different expression, she asks how the doctor has accomplished marking the skin in this particular way (line 1). She receives no answer as the interaction between the two is interrupted by the patient's complaints of pains during the insertion process as well as a beeping coming from the electronic screen. However, after these disturbances have been managed by the medical team (25.5 seconds later), the nurse re-phrases her question (line 5) and gazes at the doctor. The doctor walks around, searches for something she needs in order to complete the medical task but manages to explain that: *I took a eh a plug from e:h those saline needles* (line 6). As the doctor utters *those saline needles*, she guides the nurse's visual attention to the actual location of the saline needles. A lapse of 1.1 seconds appears (line 7) and during that lapse, the nurse freezes as she gazes at the actual saline needles (see picture A in figure 9.2 below). It is hypothesised that the actual materiality of the saline needles scaffolds the

cognitive process. They serve as a material anchor point (Hutchins, 2005) for reflection and 1.2 seconds later a result is articulated in the nurse's utterance *okay* (line 8). Another lapse of 1.5 seconds follows (line 9) before she concludes: *that was pretty clever* (line 10). During this 2.9 second event, something made sense to her and multiple dynamics in the cognitive event trajectory indicate that the nurse realises that she is on to something: she identifies the problem and links that problem to general practise (see figure 9.2).

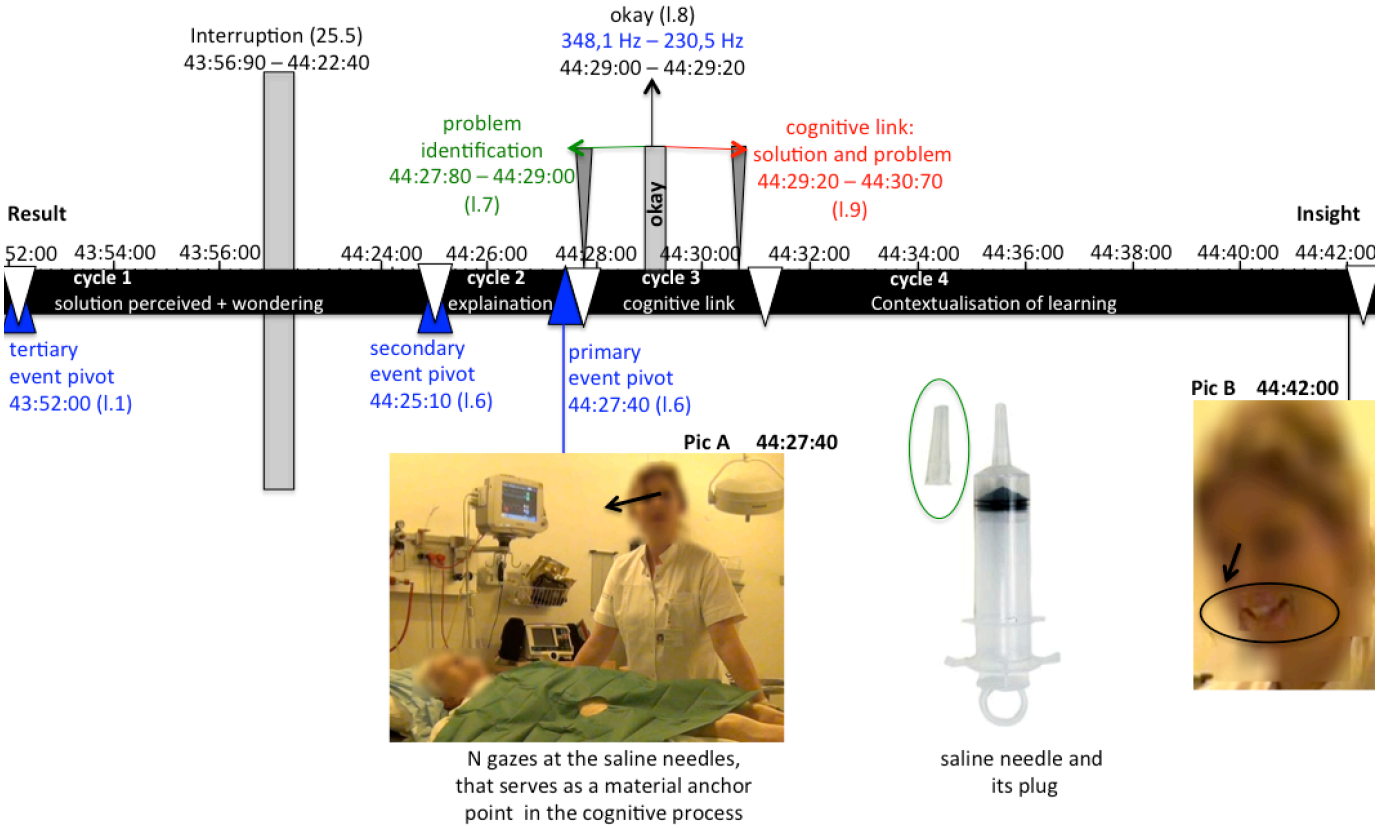


Figure 9.2: Reverse cognitive learning process

Figure 9.2 illustrates the reverse process of learning and its enabling conditions and the phases that lead to an insight. In particular, attention is given to the how the environment affords the nurse to connect non-local and local dynamics in a functional way. Specifically the nurse has (*a*) perceived a new solution to a medical task procedure, (*b*) learnt how the solution is accomplished and (*c*) identified a problem, since other methods compared to this one challenge task completion. To begin with, the new solution (the result) was not linked to a problem it was rather an event pivot that prompted the nurse's curiosity (cycle 1 in figure 9.2). The secondary event pivot is defined by the doctor's verbal explanation of what she did (line 6, cycle 2 in figure 9.2). The explanation gives the nurse relevant knowledge about how the task is completed in this situation and it allows her to compare that method to the usual ones she has knowledge about. The doctor guides the nurse's attention toward the saline needles and this activity prompts the nurse to link abstract and

actual elements in the cognitive process (cycle 3 in figure 9.2). Thus the *problem* is only experienced as the nurse has time to do the reasoning, enabled by the materiality of the needles, the explanation from the doctor and her non-situational experience with standard procedures. The sudden, realised insight indicates a local shift in the flow of interactivity, which is further supported by a vocal pitch analysis. As illustrated below the utterance of 'okay' (line 8) has a pitch range of 230,5-348,1 Hz (see cycle 3 in figure 9.2 and figure 9.3 below).

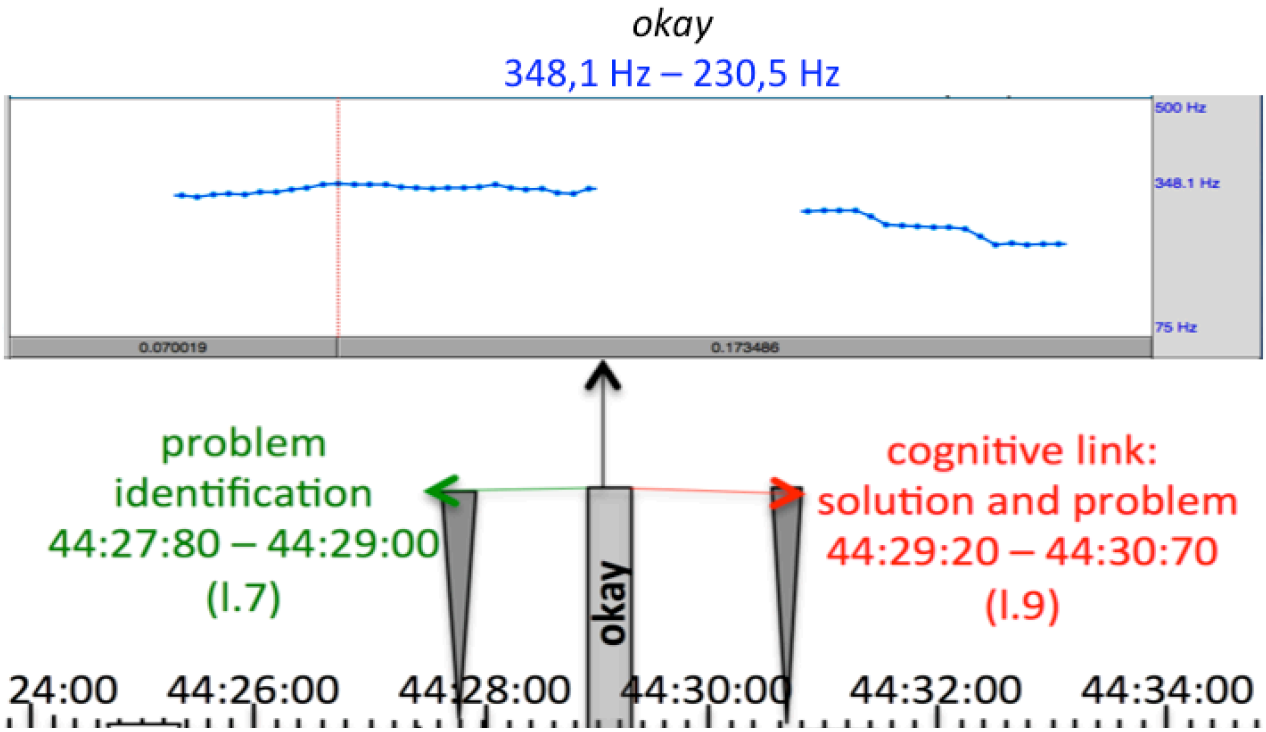


Figure 9.3: Max pitch of 'okay': 348,1 Hz. Pitch range for 'okay' in line 7: 118 Hz

At no other point in this conversation does the nurse's vocal pitch get close to this level. Her average pitch is around 250Hz and the second highest pitch point is in line 4 at the end of the question where it reaches 300 Hz. Her *okay* indicates a shift in interactivity, and it placed between two lapses (1.1 seconds and 1.4 seconds in line 7 and line 9) that surround the 0.2 seconds utterance. Before the first pause, she did not know the answer, and after the second pause everything seems to make sense and it all comes together: *I have actually also (.) often thought about that* (line 19). The lapses and the noticeable change in pitch underscore a deviation from the general flow of interactivity. As Steffensen (2013) argues: "Though we cannot observe any cognitive work, we can assume that *neurally* something is happening" (Steffensen, 2013:214). In this case, I claim that we actually do observe cognitive work embodied in the nurse's tone of voice supported by her fixated gaze during the first lapse. While the nurse identifies the information just perceived as relevant, she starts wondering, thinking and she hesitates, because something is worth connecting. Only few moments later, we perceive the results of the cognitive process as she links the local

situation to the general practice at the ward (line 10, 13 and 19).

Through a micro-sociological lens, the *okay* and *that was clever* indicate her new insight. It can be interpreted as a way of assisting the doctor to maintain face by acknowledging the new information she has received, and as such it shows her understanding of the doctor's previous turn (Heritage, 1984). Likewise, with a conventional cognitive model (e.g. Boden, 2006) the sequence becomes a sign of information processing: the nurse receives new information that is being mentally processed, modelled and stored as an internal representation that she verbalises and instantiates in future similar situations. The observation provides the nurse with a richer representational mind, and as such – the nurse as an individual - has learnt something (cf. Bandura, 1971; Schacter et al., 2011).

However, to reveal the bio-cognitive and dialogical aspect of sense-making, sociological explanations and sequential mental analysis are inadequate. By turning to interactivity, both doctor and nurse are important for the cognitive process and the cognitive result. The cognitive result is enabled by the nurse's cognitive wondering and by the doctor's cognitive problem-solving activities. The doctor perceives a problem-solving activity and the nurse perceives a solution and as such they constitute a cognitive cycle where the nurse connects and links situational dynamics with non-local patterns. As the nurse perceives the answer (44:25:00 – 44:27.80 in line 6) it 'triggers' something in her. First of all, a lapse followed by a late reply is a noticeable event pivot since nothing else requires her attention at that exact moment. That the nurse freezes for 1,1 seconds before she utters 'okay,' indicates that she is able to contextualise her new insight a few moments later. As the nurse makes explicit that the real-time perceived solution connects with a general challenge that she often faces: *I do not think I have ever seen that before* (line 13) and *I have actually also (.) often thought about that* (line 19), she smiles in a noticeable way that she has not done before during the overall conversation (see picture B). Her experience is characterised as a learning point (see figure 9.2). The nurse's bio-cognitive behaviour and the cognitive results that emerge add to our understanding of the enabling conditions for insights in interactivity. To sum up: the nurse perceives a *new* solution to general challenges in the ward. Her perception leads to learning points and richer expertise. The nested cognitive results that emerge *in situ* might lead to anticipatory problem-solving in similar future situations.

The nurse benefits from the cognitive system. She does not herself perform the solution. Rather she uses the doctor's actions (both results of action (the marking), her verbal utterances (explanations) and the material-rich environment (she gazes at the saline needles)) as a means to solution finding, problem identification and anticipatory problem-solving. Thus, the cognitive result is an outcome of coaction between nurse and doctor, with the doctor as a main agent but with the nurse as the main cogniser.

This example shows how a case of serendipity leads to a solution with no *a priori* problem attached to it. As such, the analysis contrasts traditional theories of human problem-solving that divide this process into sequential cognitive stages, as for instance:

> "1. problem categorization, 2. construction of a mental representation of the problem, 3. search for the appropriate problem-solving operators (e.g., strategies or procedures), 4. retrieval and application of those operators to the problem, 5. evaluation of problem-solving progress and solution, 6. iterating stages 1–4 if not satisfied with progress/solution, and finally 7. storage of the solution […] These stages may not be strictly sequential, but may be iterative." (Nokes and Schunn, 2010:105)

While the doctor provides the solution, the nurse makes the cognitive link between a local solution and a general problem at the ward. This connection emerges around a 0.2 second utterance *(okay)* between two lapses. Through the lens of interactivity, the 'okay' is more than a verbal stance marker that accounts for new information given (Goffman, 1959). The vocal pitch, deviates noticeably from the general pitch level in the global interactivity trajectory. Moreover, the change in the nurse's gaze pattern is salient as she suddenly fixates on the *material solution*: the saline needles. The needles become a perceptual anchor, and as such a part of the cognitive system. Within the cognitive event trajectory, the cognitive work of the nurse fluctuates and requires a variance in effort. The link between local embodied experience and abstract and general situations takes time and requires much cognitive effort (Dewey, 1910). Thus, supported by the two isolated lapses, the gaze-pattern, and the rapid timescales of pitch, it is shown how cognitive insights are facilitated in a team beyond micro-sociological collaboration and individual mental processing. As the team members prioritise sharing and caring in the pre-treatment process shared expertise becomes possible. As such they manage to navigate in and out of the dyadic and triadic cognitive system where the patient, the task and the team members are equally important and prioritised according to how the situation develops. For instance, as the doctor informs the patient about how the process is unfolding, the nurse closes the topic and moves on with procedural work.

9.3 Case II: team performance, professional evaluation and the patient's roles

In the following case example, the medical team consists of multiple team members, and most of them are from other departments. It likewise shows how sense-making teams benefit from and construct a shared expertise. The case shows a transient team constellation where most team members do not know each other beforehand. The atmosphere is calm even though the situation is acute. The interpersonal relationships are continuously managed *in situ* in parallel with medical evaluation, hypothesis generation and patient involvement. While this team performs successfully (they reach a conclusion, the patient is satisfied and the dialogical relation is characterised by professionalism and respect), the enabling conditions for the team's ability to collaborate as excellently as it does are not immediately obvious. Offhand, what appears to be the opposite of patient involvement turns out to be an example of professional caring and clear distribution of work tasks. The medical team is able of working efficiently because the practitioners jointly concert their actions in a flexible cognitive system with both tightly and loosely assembled relationships.

The medical team consists of an experienced primary doctor who has the overall responsibility, a gastrointestinal surgeon who has been called in for assistance, a medical student, an experienced nurse and a paramedic. While the doctors and the medical student constitute a relative stable team, the nurse is occupied with individual tasks and the paramedic observes at a distance as part of his further educational progress. The patient is a middle-age male who arrived with stomach cramps. He was instantly treated with morphine to reduce his pains and is now calmed down, but his condition is still acute.

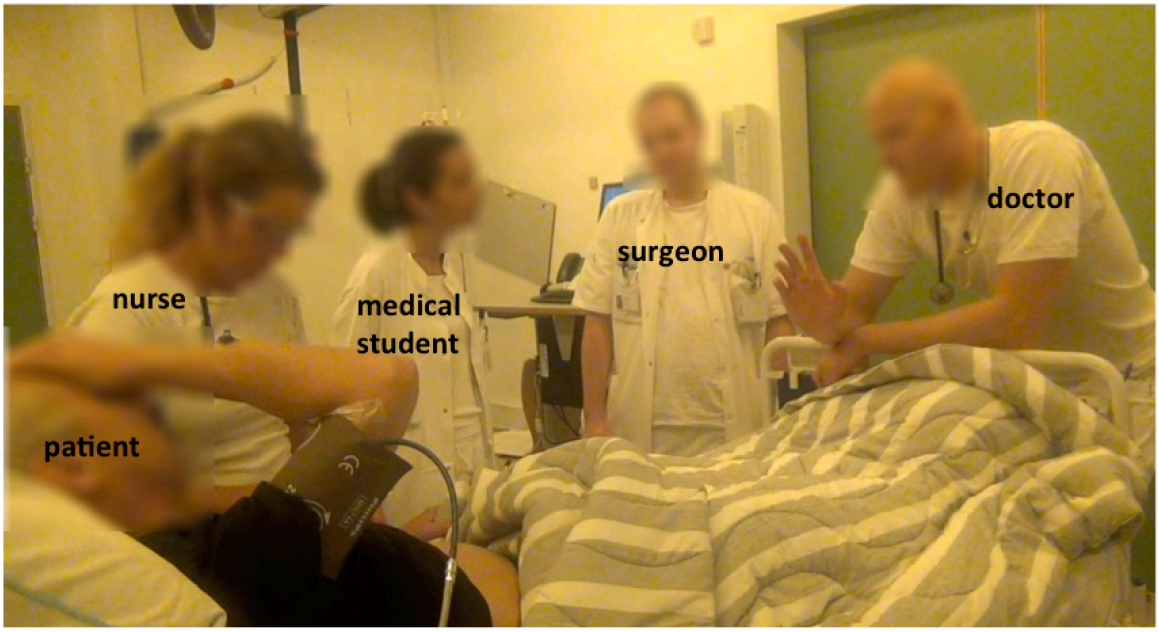


Figure 9.4: Overview of the layout: a sense-making team

9.3.1 A collaborative team: the organising power of gaze

At this point, the doctors summarise and evaluate the patient's narrative to decide how they should come up with a plan for further treatment. Specifically, they need to decide whether they should initiate surgery or gather more information about what causes the tremendous pains and they need to reach a decision immediately. On the one hand, if they choose not to operate they spend unnecessary time, money and resources on providing diagnostic imaging and analysis, and that might have consequences for the well-being of the patient if it ends with an operation anyway. On the other hand, surgery without substantial information may lead to unnecessary action, and in this case it could be a serious interference that could have been prevented. The two scenarios are discussed based on the medical measurements they have just interpreted (blood tests etc.), the patient's own narrative, information from the medical record and real-time observation of the patient. In other words, they do not know the exact problem – what is causing the pain and they need to decide what to do based on insufficient information. The sequence plays out as follows:

Transcript 9.2[32]
Duration: 00:21:10 minutes

DANISH ORIGINAL

```
1.  05:37:20, D:   °og så har der været et døgns varende diarré som jeg heller
                   ikke kan forklare°
2.  05:40:50, S:   °°ja°° (.)°nej°
3.  05:41:50, ps.  (0.7)
4.  05:42:20, P:   jeg [havde j
5.  05:42:40, D:       [og der havde han så rigtig ondt i maven da han kom ik
6.  00:44:20, ps.  (0.4)
7.  05:44:60, P:   jeg havde jo regnet med det var s bare sådan noget øhm=
8.  05:46:80, S:   bare det ikke e::r en kronisk smerte syndrom eller noget der
                   er ved at udvikle sig (xxx) plejer ikke at præsentere sig
                   sådan her (.) det plejer at komme snigende ikke os
9.  05:53:60, D:   ja
10. 05:54:00, ps.  (1.0)
11. 05:55:00, S:   spørgsmålet er om vi skulle have noget billede-diagnostik på
                   det (.) elle:r en scan
```

ENGLISH TRANSLATION

```
1.  05:37:20, D:   °and then there has been this diarrhoea for about a day which
                   I cannot explain either°
2.  05:40:50, S:   °°yes°° (.)°no°
3.  05:41:50, ps.  (0.7)
4.  05:42:20, P:   I [just I
5.  05:42:40, D:     [and at that time he had a real pain in the stomach when he
                   arrived right
6.  00:44:20, ps.  (0.4)
7.  05:44:60, P:   I just thought it was s a kind of a ehm=
8.  05:46:80, S:   as long as it i::s not an chronic pain syndrome or something
                   that is about to develop (xxx) usually not presenting itself
                   like this (.) it usually progresses slowly right
9.  05:53:60, D:   yes
10. 05:54:00, ps.  (1.0)
11. 05:55:00, S:   the question is whether we should have some imaging on this
                   (.) o:r a scan
```

The two doctors are absorbed in the diagnostic process and, as we enter the conversation, the doctor lists unsolved circumstances in a low voice to the surgeon (line 1). Both doctors are facing the patient, but they gaze at his body and more specifically at his stomach, which is the locus of the medical problem. Momentarily, they briefly gaze at each other but at no time at the patient.

The medical student observes the overall situation but she has, qua her role as a doctor *in spe,* an interest in the medical problem-solving managed by the two doctors who are also

[32] In the transcript, S stands for surgeon.

the main cognisers in this event. During this excerpt the medical student and the nurse do not say anything. The nurse is occupied with a procedural task.

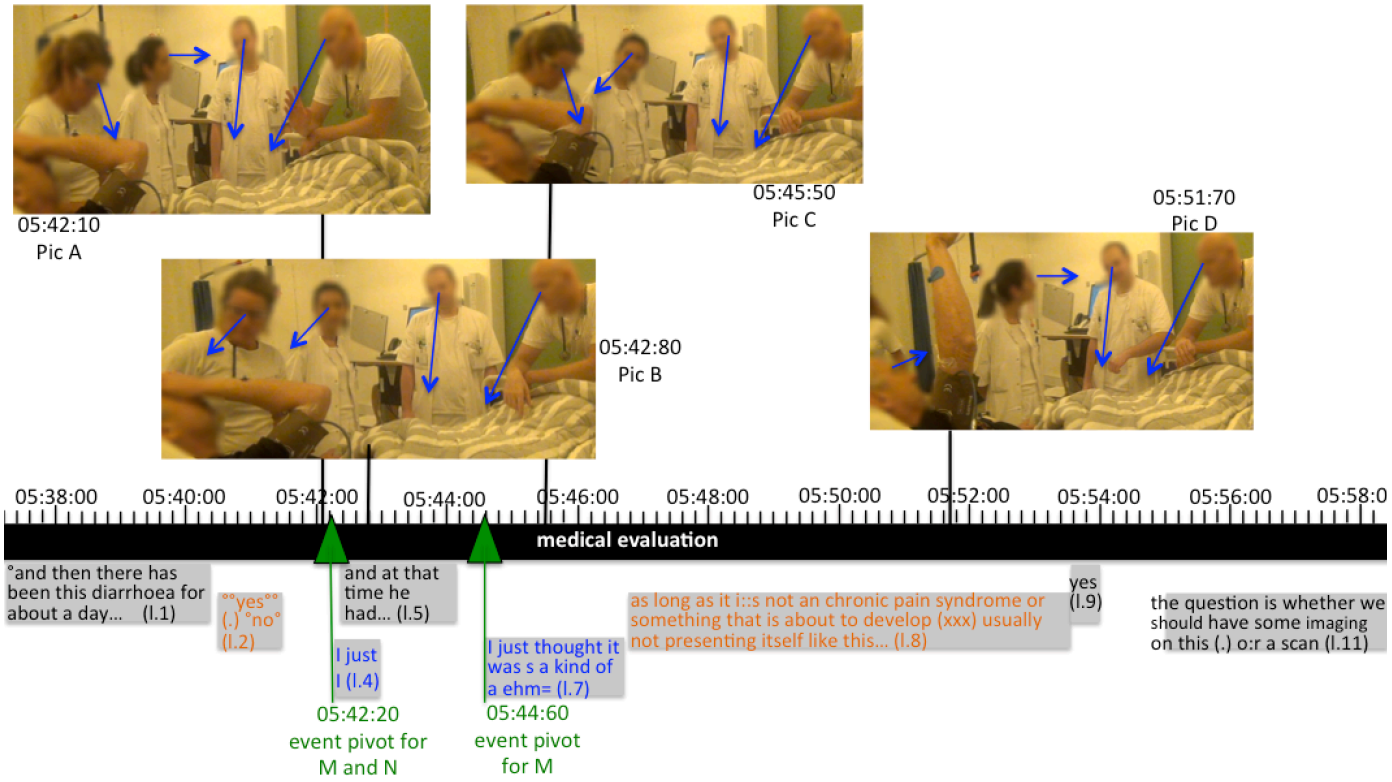


Figure 9.5: The function of team management of changes in the layout of affordances

The figure illustrates how interruptions are managed in accord with how the situation develops. Within the figure, event pivots are indicated but as will be explained, the pivots only become affordances for action for some parties within the team.

All practitioners are occupied with the medical problem-solving and no one gazes at the patient's face (see picture A). The patient covers his eyes with his hand, which narrows down his visual system. However, as a pause of 0.7 seconds emerges (line 3), the patient takes advantage of the break to share his concerns, but the doctor immediately interrupts him. Only 0.2 seconds after the patient starts to utter: *I [just I* (line 4), the doctor continues the narrative with the surgeon. None of the doctors respond to the patient's remark, neither verbally nor non-verbally; consequently the patient stops himself in the middle of his utterance. While the doctors continue as if nothing happened, both the nurse and the medical student gaze immediately at the patient's face. Only 100 milliseconds pass from when the patient starts his utterance until the two practitioners turn their heads. The patient's utterance is identified as an event pivot for the nurse and the medical student who react to his speech at the exact same time (see figure 9.5). The nurse temporarily suspends her task and looks up and the medical student ignores the medical interaction and orients to the patient (see picture B). Neither of the doctors change their visual orientation. After 2.3

seconds the nurse resumes the medical task and only the medical student continues to gaze at the patient's face, in total for 8.3 seconds.

As soon as the doctor has completed his utterance a new pause of 0.4 seconds emerges and the patient once again tries to contribute with his own view: *I just thought it was s a kind of a ehm=* (line 7). This time the surgeon cuts off the patient just as the patient was about to explain what he thought was the matter with him. This time only the medical student gazes at the patient's face. The rest of the team on the contrary, 'non-reacts' to the patient's remark even though he speaks out loud and clear (see picture C). After this non-reaction, the patient removes his arm from his forehead and grabs on to the handle in the ceiling. The patient holds on to the handle, which entails a more participatory behaviour, as he is able to gain eye contact with the doctors. As this happens the medical student stops gazing at the patient and continues to learn from the medical evaluation (picture D).

From a micro-sociological perspective, it is relevant to dwell on the timing of the patient's interruption and interference. The patient takes the turn at a relevant place. His verbal expression is coordinated in accordance with the doctor's utterances. Thus, as the doctor's turn is complete, the patient takes the next turn. However, the response remains absent. Rather than being an example of insensitive and non-dialogical behaviour, investigations of whole-bodied coordination reveal quite the opposite picture. With the interactivity perspective, a multi-scalar approach includes dynamics beyond the enchronical scale of interaction. By tuning in on how gaze serves as a coordinating resource that allows for flexible and dynamical organisation within the team it shows how the team is functionally defined by individual roles and priorities. The doctors continue their professional evaluation of the patient, the medical student stands by and takes note of the overall situation, and the nurse reacts and observes to see if something critical emerges, and then soon resumes her task.

Efficient and coordinated teams are defined as individuals that perform differently but share a common objective and priority (in this case diagnosis and pre-treatment). This excerpt pivots on how this team co-acts via coordination of gaze. Thus, through gaze, the patient's request is responded to, but it is not treated as an affordance for dialogue. Moreover, caring for the patient in the long run requires other situated actions (Pedersen, 2010; 2012; Hodges, 2007a; 2007b).

In this case, the changes in the cognitive system do not lead to task switch (interaction with the patient). The apparently non-dialogical behaviour is not a consequence of reduced sensitivity or stress; rather, it is an expression of overview, clear priorities and efficient distribution of responsibility. The organising power of gaze shows in the team's ability to perceive and act on relevant changes. They adapt smoothly to the situation with a minimum of cognitive effort and disturbance. Even though the situation is acute, the team performs calmly and professionally and it marks the work of the healthcare professionals as highly coordinated. In this moment, it is not the time to bring in the patient's ideas that will only disturb a focused argumentation amongst the doctors that are also under time pressure to come up with a plan for further treatment.

Interestingly, the actions of the medical student deviate from the rest of the team

members. While the cognitive event trajectory indicates a smooth interactivity trajectory, where potential event pivots remain *potentialities* for the medical team (the patient's utterances do not lead to a change in the cognitive agenda), the medical student freezes and her gaze is fixated at the patient's face for 8.3 seconds. To the nurse, the first utterance of the patient becomes a minimal disturbance that briefly disrupts her work. For the medical student, both utterances of the patient become event pivots that make her unable to attend the medical evaluation for 8.3 seconds. The medical student might perceive the patient's expression as an affordance for dialogue, but constraints such as her position as the lowest in the professional role hierarchy, the fact that she is the least experienced in the team and her role as an observer rather than a full member of the medical team could be explanations to why she keeps focus on him for a long time, yet ends up doing nothing. Another explanation is that as a novice, she relies on the experienced team's sense-making and learns from their behaviour. The nurse immediately identifies the non-critical comment and the doctors continue to complete another important task. The medical student does not have the same expertise as the other team members who are all highly experienced practitioners. Intuitively, she might not have the same sense for how to prioritise and balance multiple values: caring and moving on in terms of interpersonal communication and medical evaluation. In previous case examples, novices often attempt to realise multiple values simultaneously, which leads to salient changes in the interactivity trajectory and is often enabled by stress, confusion and frustration. In this case, the team maintains a constant interactivity pattern even though changes are enacted. However, they have no consequences for the functionality of the cognitive system: the patient's interruption is not a difference that makes a difference, to paraphrase Bateson (1972).

A verbal expression is a social affordance for integrating behaviour. In this concrete example, however, it is *not* picked up as an opportunity for dialogue. Dialogical expertise is related to the ability to instantly know when and where to pick up on changes in the layout of affordances. The medical cognitive system is able to reconfigure its boundaries as the gazes of the various team members indicate a precise distribution of responsibility and tasks.

Coordinated and efficient team performance is characterised by the team's ability to distribute responsibility and adapt flexibly to changes in the environment rather than by following predefined and fixed procedures about who should do what in pre-defined scenarios. Learning possibilities are easier apprehended within teams than in individual-based situations as people inspire and constrain each other. As healthcare professionals, given their reciprocal relationship, co-articulate, co-act and coordinate they become bound up with each other's distinctive medical histories and ways of performing as professionals (Thibault, 2014). As this happens, medical teams co-modify and co-adapt *in situ*, which results in coaction enabled by conditions that relate to multiple time-scales and which link endogenous and exogenous conditions for interactivity (Thibault, 2014). The medical student perceives the actions of the team and over time her expertise becomes richer and more automatised. Such automatisation is what characterises the team's sense-making processes. Further, when experts make sense in real-life, they do not only follow social

rules. They balance multiple tasks and values, which, depending on the situation entails a behaviour that is unpredictable in advance. The 'right thing' to do, both interpersonally and medically emerges *pari passu* with the act of perceiving what to do with what the environment offers, and with the cognitive system's ability to adapt to the changes in situ. In this case *conversational ignoring* is necessary if caring for the patient is to be realised in the longer run. To some degree emergency medicine is about routine practice, and there are numerous procedures and protocols that enhance work practice and contribute to safe and standardised outcomes. However, unexpected and sudden changes unpacked in milliseconds give the practitioners narrow possibilities for reflection. Generally, while novices allocate a lot of cognitive effort into rule-following processes, experienced practitioners rely on expertise defined as an embodied intuition equipped with experience over time (Merleau-Ponty, 1992). In this case the experienced team relies on an embodied historicity, which releases cognitive power to important tasks. This case example shows the importance of team performance. Much can happen simultaneously, and joint sense-making emerges as interactivity connects individual behaviours in a shared trajectory.

In the final excerpt the case is turned around. The patient comments on the team's medical evaluation and his comments require immediate response and explicit attention from the medical team. The patient becomes a part of the cognitive system as the doctors manage to re-organise its boundaries through coordination of gaze, body movements, tone of voice and change in vocabulary.

9.3.2 Managing boundary constraints in a cognitive system

This excerpt investigates the interactional constraints when the two main cognisers (the surgeon and the doctor) evaluate the patient in a precise, medical language while the patient is present. In continuation of the previous excerpt the two doctors share their thoughts just to make sure that they agree that they have reached a shared and respectable decision. Attention is given to the team's shared coordination of repair and re-calibration of the cognitive system as the patient utters a relevant concern.

Transcript 9.3

Duration: 00:43:40 minutes

DANISH ORIGINAL

```
1.  06:12:80, D:   næ:: [det synes jeg er en fin ide
2.  06:13:00, S:        [jeg tænker vel bare vi skal have god indsigt i abdomen i
                   hvert fald [ik så så vi: øh kan med sikkerhed sige: ikke (.)
                   er noget galt
3.  06:15:20, D:             [ja
4.  06:19:00, D:   ja
5.  06:19:30, S:   inden vi begynder o:g og lukke op i dig og kigge ind
6.  06:21:60, D:   ja ja men det synes jeg er en ([xxx) er en udmærket approach
7.  06:22:70, P:                                  [nu må I sgu da lige styre jer
8.  06:24:90, ps.  (0.6) (all laughing, except P)
```

9. 06:25:50, D: VI STÅR O:G (.) OG SNAKKER OM VI SYNES DET ER EN GOD IDE OG LIGE AT TAGE DEN LIDT MED RO FØRST↓
10. 06:30:00, ps. (0.4)
11. 06:30:40, D: O[G LI:GE STARTE MED NOGET (.) pænt ik
12. 06:30:50, P: [før I åbner mig op
13. 06:33:60, S: jo=
14. 06:34:00, D: =ja
15. 06:34:50, P: nu havde jeg det lige så godt
16. 06:35:30, S: ja::
17. 06:35:70, ps. (0.8) (student and paramedic laugh)
18. 06:36:50, P: (x[xx)
19. 06:36:80, S: [vi starter med at tage e en sca en CT scanning ik↑
20. 06:39:50, P: jo
21. 06:39:80, ps. (0.9)
22. 06:40:70, S: af maven
23. 06:41:20, ps. (0.6)
24. 06:41:80, P: °ja°=
25. 06:42:20, S: =og så ser vi: på den og får den beskrevet af en røntgenlæge
26. 06:44:50, ps. (0.6)
27. 06:45:10, P: °okay°
28. 06:45:90, D: det var ikke pænt sagt↓
29. 06:46:60, ps. (1.2)
30. 06:47:80, P: nårh (xxx)
31. 06:49:80, D: nå så skriver jeg en journal (.) og så ø:::h bestiller jeg en CT (.) og så kommer han op til dig og så: øh: °må vi se på det°

ENGLISH TRANSLATION

1. 06:12:80, D: no:: [I think that is a good idea
2. 06:13:00, S: [in any case I think we need a good idea about what is going on inside the abdomen right [well so so we: eh can with certainty say: nothing (.) is wrong
3. 06:15:20, D: [yes
4. 06:19:00, D: yes
5. 06:19:30, S: before we decide to: open you up
6. 06:21:60, D: yes yes but I that is a ([xxx) a fine approach
7. 06:22:70, P: [you need to get it together guys
8. 06:24:90, ps. (0.6) (all laughing, except P)
9. 06:25:50, D: WE ARE JU:ST (.) TALKING ABOUT WE THINK IT IS A GOOD IDEA TO JUST TAKE IT KIND OF EASY TO BEGIN WITH↓
10. 06:30:00, ps. (0.4)
11. 06:30:40, D: A[ND JU:ST START WITH SOMETHING (.) nice right
12. 06:30:50, P: [before you decide to open me up
13. 06:33:60, S: yes=
14. 06:34:00, D: =yes
15. 06:34:50, P: I was just starting to feel well
16. 06:35:30, S: ye::s
17. 06:35:70, ps. (0.8) (student and paramedic laugh)
18. 06:36:50, P: (x[xx)
19. 06:36:80, S: [we will first take a a sca a CT scan right↑
20. 06:39:50, P: yes
21. 06:39:80, ps. (0.9)
22. 06:40:70, S: of the stomach
23. 06:41:20, ps. (0.6)

24. 06:41:80, P: °yes°=
25. 06:42:20, S: =and then we: will go through that and have it described by an x-ray doctor
26. 06:44:50, ps. (0.6)
27. 06:45:10, P: °okay°
28. 06:45:90, D: that was not a nice thing to say↓
29. 06:46:60, ps. (1.2)
30. 06:47:80, P: well (xxx)
31. 06:49:80, D: well then I will write a record (.) and e:::h I order a CT (.) and then he will come back to you and the:n eh °we will take it from there°

The surgeon emphasises that the next step is to get sufficient insight into the abdomen. As the surgeon utters: *with certainty say:* both doctors nod in agreement and they have eye contact. Until this moment the two physicians have constituted a relatively stable cognitive system. Until now, they have gazed at the patient's stomach and momentarily at each other. They have spoken in a lower voice, which further demarcates the boundary of the cognitive system. This constellation changes as the doctors are about to reach a conclusion and utter this in a way that prompts the patient to participate in the interaction. In contrast to the previous interruptions the doctors treat this one as an affordance for dialogue. This is visualised in the following figure 9.6.

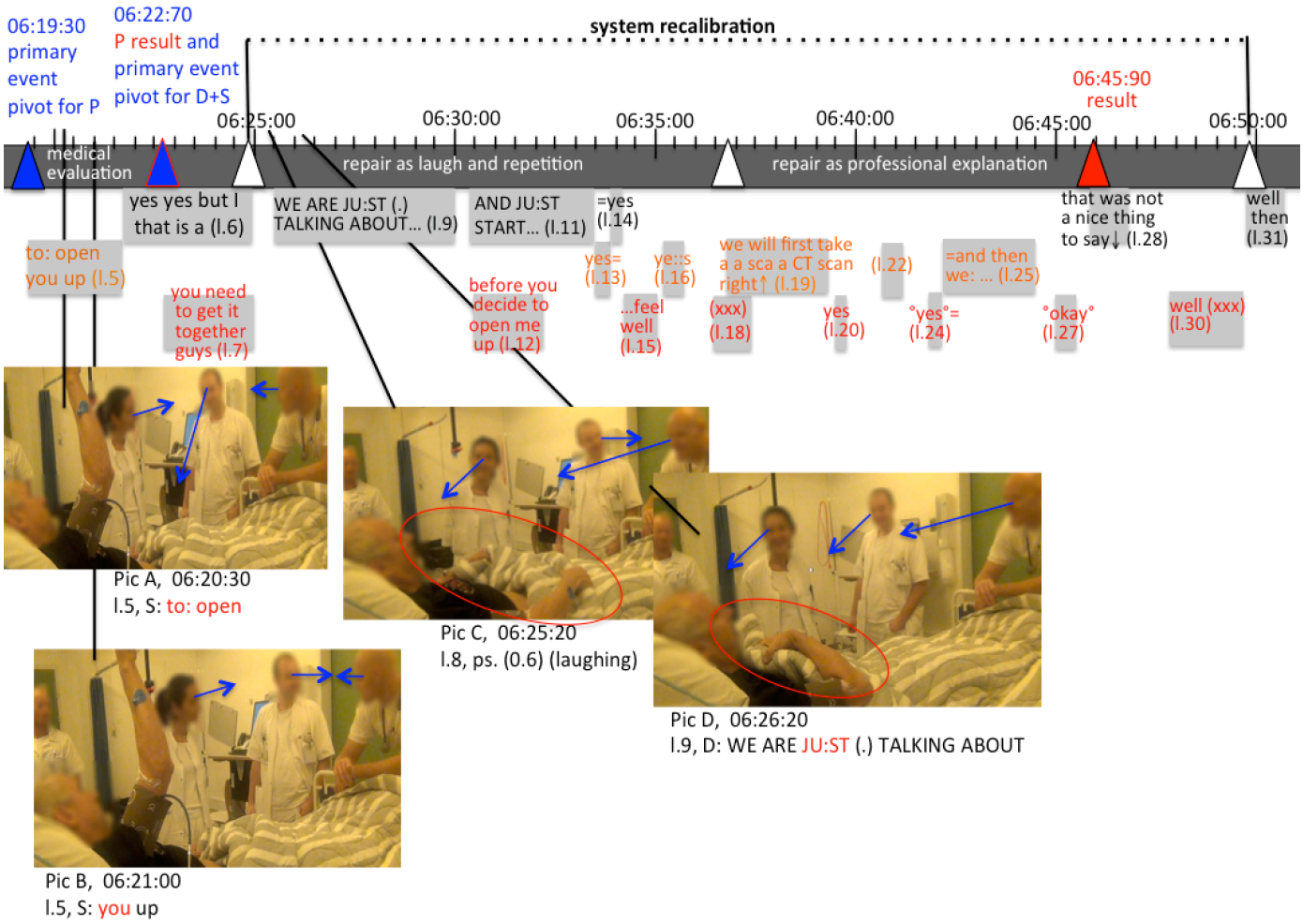


Figure 9.6: System recalibration

Overall, the figure shows how the medical team is able to manage a potential critical situation by moving from medical evaluation to dialogue with the patient and back to professional discussion again. The team uses two repair strategies that enable it to recalibrate the cognitive system in a way that allows for patient inclusion without losing sight of the professional task. In what follows it is investigated what enables the team to manage this challenge efficiently and dialogically.

As the doctors have reached a decision (line 4), the surgeon nods towards the patient's stomach and gazes in the same direction when uttering: *before we decide to: open you up* (line 5). As he utters: *to: open* he gazes at the patient's stomach, but as he continues his verbal utterance *up* (the rest of line 5) he changes his visual orientation and gazes at the doctor (see picture B). Linguistically, the deictic 'you' in line 5 refers to the patient and indicates a shift in the interactivity, as the conversation now involves the patient. Both the *open you* and the gaze towards the patient serve as a primary event pivot that leads to patient involvement (see figure 9.6).

Before line 5, the patient was a medical object of discussion and the doctors mainly addressed him in third person 'he' (see the previous transcript 9.2, line 5) or parts of his

body (the abdomen) (see transcript 9.3, line 1). Yet, the deictic 'you' reconfigures the relations in the cognitive system, so the patient is now directly addressed. The whole process seems ambiguous, though. On the one hand the surgeon indicates a transition from the diagnostic process to an informational period where the patient is being informed about what they have discussed and their recommendations for further treatment. But, where the deictic 'you' refers to the patient the nod towards the stomach both points to the patient as a subject and to the stomach as an object.

The surgeon never gains eye contact with the patient. He gazes briefly at the patient's stomach as the doctor remains focused on the surgeon, and the surgeon immediately regains eye contact with the doctor (see picture B). At no time have the doctors gazed at the patient and after this explicating episode, the doctors re-establish a dyadic relation. Thus, the surgeon both attends and dis-attends to the patient. However, when the doctor utters *yes yes but I that is a ([xxx)* (line 6), the patient grabs the handle and raises his head. Immediately, the doctor gazes at the patient's face. As the patient raises himself up in the bed, the patient utters: *you need to get it together guys* (line 7) after which the patient falls back into bed and lets his arms down. This action serves as a crucial primary event pivot for the doctors as they immediately react to patient's utterance: they laugh and the patient immediately pulls up the duvet just under his chin and holds on to it in a noticeable way as if he wants to protect the exposed part of his body: the uncovered stomach (see picture C and D). 1.3 seconds pass from when the surgeon has completed the utterance *before we decide to o:pen you up,* 06:21:70, line 5, until the patient responds 06:23:00, line 7. While it is old news that surgery is a possible action, the patient seems to respond to the *wordings* in the context *to: open you up*. The patient repeats these words in line 9: *[before you decide to open me up.* Goodwin (2013) shows how individuals often reuse resources that are provided previously in the context in order to build new actions. The co-operative act entails a change in the interactivity trajectory as the wordings of surgeon's professional evaluation is repeated to create a tragi-comical atmosphere (they all laugh). Goodwin argues that this process of "systematically modifying that structure to build something new, is a central, distinctive feature of human action, one that makes it possible for human culture and knowledge to accumulate in a systematic fashion" (Goodwin, 2013:9). Thus, for this action to be meaningful and possible, the patient and the medical team must share a cultural understanding of such co-operative action. As competent members of a shared cultural and cognitive system they are able to co-operatively make sense of the linking between the surgeon's and the patient's perspectives respectively, and as a result they laugh. The surgeon's deictic reference (*you*), the patient's verbal interruption and his physical protective embodiments are important event pivots that serve as affordances for dialogue. Thus, the result is a dialogue where laughter and professional explanation recalibrate the cognitive system (see figure 9.6). Prompted by the specific wordings: *open you up*, the patient's dramatic and demonstrative action becomes a way of combining seriousness with drama. After the patient has uttered that they should take it easy and covered his stomach with the duvet, the medical team bursts into laughter (line 8). The laughter within the team and the act by the patient frame the situation as a tragi-comical

event, where the patient seems shocked and at the same time responds to the laughter with an ambiguous act that is both serious and comical. With the duvet as a 'safeguard layer' the interpersonal relationship between the patient and the doctors is potentially exposed and constrained. All except for the patient laugh. Just as the patient has pulled up the duvet, the surgeon suddenly takes a couple of steps to the side and forward as he moves away from the doctor and closer to the patient (see picture C and D). For several moments the surgeon has not moved and until this moment, as the two physicians have established a relatively stable relationship. This relationship is now changed by the physical reorganisation, the actions of the patient, and the laugh that connects all members as a shared team.

It is ambiguous how the patient feels. However, several dramatic actions indicate a kind of shock condition that changes the flow of interactivity noticeably. In other words, unless the interpersonal relationship is further constrained, the doctors will need to handle this situation professionally and dialogically. While the two doctors previously ignored the patient's utterance, they now respond to his concerns immediately, both verbally and in bodily movements. The doctor raises his volume remarkably as he utters that they were indeed agreeing on taking it easy to begin with (line 9), and he gazes at the medical team and at the patient's face. Moreover, they speak louder, the surgeon radically changes his position so he faces everyone in the ward, and the vocabulary is less specialised and serious, and as such the cognitive system recalibrates and reconfigures its boundaries. For 11.9 seconds the doctor manages the situation by responding to the patient's interruption and the laugh is an important coordinative factor in this interpersonal repair (see figure 9.6).

As the patient continues the tragi-comical form and states: *I was just starting to feel better* (line 15), once again the medical team laughs. The paramedic and the medical student continue to laugh. Again the patient contributes to the dialogue (line 18) only this time the surgeon interrupts and changes the tragi-comical genre to a serious and professional one. As the surgeon interrupts, he changes the phase of repair through laughter to one of professional explanation (see figure 9.6). The surgeon's interruption, his professional explanation and his embodiment enable him to recalibrate the system, so that a serious approach can be maintained. The other team members stop laughing and the surgeon explains the factual medical procedures of the situation. As the surgeon addresses the patient and explains and summarises what is going to happen, he uses the category 'stomach' rather than 'abdomen,' which was the preferred term in the interaction with the doctor.

Later on, as the surgeon utters *have it described by an x-ray doctor* (line 25), the doctor covers his mouth with his right hand. He then removes it a bit and scratches his chin as he responds to the earlier reaction by the patient with the comment: *That was not a nice thing to say↓* (line 28). Exactly 24.0 seconds after the surgeon has uttered the 'critical' comment in line 5, the doctor makes a very late repair (the result prompted by the primary event pivot in line 7). This response makes the doctor appear understanding and empathetic, because he puts himself in the position of the patient. When the practitioners move outside

their own medical domain and 'observe' their utterance as critical wordings (*open you up*) from the perspective of the patient, they see the critical aspect of their formulation (that was not a nice thing to say). Thus, the major challenge in this case is to balance different professional domains. The doctors need to exchange their medical hypotheses in a professional domain, which sometimes expands to or interferes with the domain of the patient. There are no rules for how the patient should be included in medical dialogues. As I have shown, it depends both on inter-bodily dynamics (laughter, gesture, words, gaze) and the overall situation (e.g. time constraints). A verbal utterance from the patient in itself is not an affordance for dialogue. Sense-making is enabled by far more complex and dynamic features than verbal patterns.

A functional cognitive system produces a coordinated agency. This seems to match the experience of the team. While the doctor excuses himself for being impolite, he was not the one who uttered the critical comment. However, the atmosphere and mood do not seem to be caused by one or two words uttered in isolation, but by the flow of interactivity that has been guided by shared activities. The cognitive system entails shared activity as an ongoing accomplishment that is not about what single individuals do, but about how a team acts within on-going processes in interactivity. The medical team's laughter, the surgeon's professional explanation and the doctor's late repair serve as negative feedback-mechanisms that enable the self-organisation of the cognitive system and recalibration of the interactivity trajectory (see figure 9.6).

9.4 Conclusion: the benefits of team performance in an educational perspective

In the first case example, insight emerges as specific non-local and situated work domains are linked. The nurse learns from the collaboration with the doctor and this result is one of the major advantages of team performance. In emergency medicine, the team constellations are often ad hoc and teamwork is challenged by the vulnerability of exposing one's expertise and knowledge in new situations and in new interpersonal relations where level of expertise and knowledge are explicit in tasks, procedures, and formal and informal roles. Within such constraints, team members need to be open, vulnerable and able to share and change strategies as the situation changes and plans prove unsuccessful. Thus, safe and dialogical team performance relies on trust and confidence with the tasks, roles and work practices. If the culture works against such criteria, functional team performance is inhibited (Pedersen, 2010). However, ad hoc team constellations also scaffold unique possibilities for learning. When teams are fixed, standard procedures are automatised and become tacit, which is a valuable quality in highly structured and known environments. However, in the emergency wards much relies on the team's ability to respond to the unknown. Within the first case example, insights emerge as the nurse perceives a new approach to a standard procedure. If the team constellations become fixed, such learning possibilities decrease, as new correlations are unlikely to emerge to the same extent as in new constellations.

In the final cases, it is exemplified how error cycles are more likely to be managed efficiently in teams than in situations that are handled individually. The team members are

perceptual detectors that jointly enlarge the visual system and as such pico-scale changes are more likely to be identified and encountered in a team as multiple goals can be accomplished at the same time. Thus, effective coordination and distribution of tasks, roles, and responsibilities release cognitive power to maintain the overview of the overall interactivity.

Finally, expertise is a crucial factor in successful and efficient problem-solving in stressful environments, and by combining novice and experienced practitioners in teams, learning is much more likely to emerge as a result of meaningful interactivity than from intuition when practitioners operate individually. The experienced practitioner is able to point to changes in the layout of affordances and as such the feedback-mechanisms become explicit for the less skilled practitioner. Merleau-Ponty underlines the importance of bodily experience when acquiring new habits:

> Acquiring a habit as the reworking and renewal of the body schema presents significant difficulties for classical philosophers, which are always inclined to conceive of synthesis as intellectual synthesis […] the subject does not weld individual movement to individual stimuli, but rather acquires the power of responding with a certain type of solution to a certain form of situation. (Merlaeu-Ponty, 2012:143)

In this sense, habits and expertise are neither reduced to abstract knowledge nor automatic reflex, but rather "knowledge in our hands, which is only given through a bodily effort and cannot be translated by an objective designation" (Merlaeu-Ponty, 2012:145). Further, when Merleau-Ponty exemplifies how a blind man's stick ceases to be an object for the man (or merges into our body schema causing an extended peri-personal function (Kirsh, 2014)), the same explanation applies to the function of individuals within a team. From a cognitive perspective, when coordinated, the individual team members cease to be distinct properties in the system, as they perform as one functional system. Thus, the medical student learns from being part of the team's sense-making activities. Most likely, she is not explicitly aware of the particular sense-making values the team realises, but by engaging in interactivity, her body schema is saturated and changed by the local interaction. By extending Merleau-Ponty's idea of how the individual habituates oneself to an environment of objects, to include interactivity, the qualities of working in teams become clear. By emphasising the value of interactivity, the effect of language is unavoidable. In a team we do not just absorb each other as objects; we trust and rely on second-hand perception (Steffensen, 2013; Gibson, 1966). Thus, if trust is missing, coordinated sense-making is less likely to happen; linked to this case, the medical student would not accept the team's decision of non-dialogue for instance.

When the novice works individually, learning emerges - as Merleau-Ponty emphasises - through bodily effort to respond to the environment in a certain way. Thus, when the novice works in a team, she relies not only on individual perceptions, but also on second-hand perceptions, and in this case, it enables the student to skip a level compared to individual learning settings. As the team non-reacts to the patient's utterance, she continues to gaze at the patient. Even though she does not know why the team acts as it does in the situation, she comes to experience the functional output. Indeed, by working in a team, the team members

share the responsibility for dialogue and, as they concert movement, talk and action, the team jointly recalibrates its boundaries, for instance in cases of unfortunate utterances.

Finally, both cases reveal the learning potential of teamwork. Further, working in teams increases the chances for negative feedback mechanisms in the system, as each team member can recalibrate the system in different ways depending on expertise and situational affordances for action. Thus, in relation to human errors, much can be learned from understanding the underlying dynamics of successful team coordination. The overall analysis encourages an anticipatory approach to human errors, where work practice is arranged in accord with its insights. As such, knowledge about human errors do not need not to be extrapolated from observing human errors in themselves, rather by observing successful coordination, latent conditions for errors can, to an extent, be minimised in advance.

10. Documentation in electronic medical records: the function of gesture, voice dynamics and gaze

10.1 Integrating typing and verbal interaction

One of the main obligatory tasks in the ward is documentation in the electronic medical record. This main task takes up a lot of time and effort during the overall diagnostic task. Previously, documentation was completed outside the emergency room with pen and paper. Today, technological artefacts and software programs have innovated this task. Moreover, the process is managed next to the patient to enhance dialogue during the process and to detect potential misunderstandings *in situ*. All doctors complete this task, but the way they do it differs to a large extent. Coding brings forth two overall interactivity trajectories in relation to this task performance: a dialogical trajectory rich on embodiment that enables the inclusion of the patient during documentation and a monological and sequential trajectory where embodied behaviour is constrained by the practitioner's fixation on the computer, which excludes the patient from being part of the cognitive system. Performing this task dialogically requires an ability of the doctor to mesh both artefact and patient interaction: in other words, integrating typing and verbal interaction during documentation.

Writing and typing have been viewed as a code with a one-to-one correspondence to language in interaction (Kravchenko, 2011:33). However, a radical view within linguistics distinguishes writing and speech as ontologically different cognitive activities (Kravchenko, 2007; 2011; Love, 2004; 2007; Linell, 2005). If the ward's intention of dialogical task performance is to be achieved, it is required that the healthcare practitioner is able to mesh and navigate smoothly in and out of the distinctive cognitive processes of typing and patient-interaction. This challenge entails a focus on how dialogical documentation processes are achieved. As this chapter will show, such smooth navigation requires the implementation of creative embodied strategies. Thus, the chapter investigates healthcare professionals' different use of embodied resources, especially gesture, gaze and voice dynamics as they perform this obligatory task in front of the computer. It further identifies general constraints for a rich, embodied behaviour in this task, such as meshing typing-activities and verbal interaction or using artefacts and being sensitive to inter-bodily

dynamics, for instance.

> Clearly, a good deal of expertise in the system is in the artifacts (both the external implements and the internal strategies)–not in the sense that the artifacts are themselves intelligent or expert agents, or because the act of getting into coordination with the artifacts constitutes an expert performance by the person; rather, the system of person-in-interaction-with-technology exhibits expertise. (Hutchins, 1995a:155)

As Hutchins emphasises, the expertise that a person-in-interaction-with-technology gains is unique: documentation in the electronic medical record reduces the chances for human error as the information is standardised, the output is readable and the process is fast compared to handwritten medical record-keeping. Moreover, the chronological step-by-step commands on screen structure the task and hence the interaction with the patient. While the electronic procedures secure a uniform and comparable documentation outcome, they likewise, as in other task performances, dictate a hierarchy of relevance that does not necessarily correspond to the relevance of the actual situation.

Generally, the number of electronic artefacts in the medical ward is increasing drastically and the risk of such technological advancements is that the patient becomes secondary in parts of the diagnostic task. Often the implementation of such artefacts is based on the assumption that electronic equipment unambiguously scaffolds cognitive processes in a way that increases efficiency and standardises output. It is hypothesised that such artefact optimism is grounded in an economical cost-benefit metaphor that does not consider contextual issues and emotional dynamics as potential constraints for efficient and logical task performance. As analyses in chapter 5 and 6 have shown, the way that artefacts are handled is crucial to outcome.

It is hypothesised that the more profound use of embodied resources such as gesture, voice dynamics, gaze and movement during task performance, the more fluidly the two different activities will be managed and the more aligned the patient and the practitioner will be. Attention is thus given to how rich embodiment prompts understandings, affords participatory behaviour, scaffolds precise pain localisation, enhances memory of specific non-local and local experiences and enables the achievement of nested activities. In particular, focus is on how the use of gesture, gaze and voice dynamics contribute to the achievement of a cognitive task. With the interactivity perspective, the function of such embodied resources are intertwined with the articulation of verbal utterances and the material environment (Streeck et al., 2011; Goodwin, 2000a; 2009). In that sense, embodiment is a biosocial resource that enables coordination and mutual attunement (Cowley, 2011).

In the following, it is investigated how three doctors perform the documentation task very differently and depending on the function of embodied dynamics, contribute to a monological or dialogical interactivity trajectory. The first part focuses on how a doctor follows protocol and document required information in the electronic medical record in accordance with guidelines from medical textbooks. While no dysfunctional output is identified in this case, it becomes clear how performance based on fixed rule-following,

diverges from best practice when it is compared to performances based on a flexible and creative approach. The second and third cases focus on how two doctors mesh procedures with situational affordances in a way that enhances efficiency and dialogical relationships. Specifically, they use embodied resources as a means for identifying pain areas, description of symptoms, enaction of memory related to the medical narrative and finally, to achieve multiple goals simultaneously.

The analyses use the interactivity-based framework to investigate how doctors rely on multiple timescales and material dynamics in the cognitive system. With CEA the cognitive event trajectories unveil how, from a medical point of view, relevant event pivots go unnoticed amongst the doctors. Furthermore, distributed language including ecological theory of gesture (Streeck, 2010; Goodwin, 2009) is applied to show the valuable significance gestures have for dialogical cognitive outcomes.

10.2 Case I: the iPatient is only a model of the patient

The following case presents two paradoxes in the documentation activity. First, it pivots on the paradox that while the doctor follows protocol she becomes inhibited in performing the task efficiently and dialogically in a way that serves the patient's understanding of what is going on. The second paradox relates to the facts that while the members in interaction do not perceive the situation as constrained: an observer's perspective provides an adverse and critical evaluation. This will be discussed on the basis of comparative analysis of this case and the two consecutive examples of best practice.

The situation of case I is characterised by a doctor's step-by-step procedure following. She has just completed obligatory steps in the diagnostic process (history-taking and physical examination) and as we enter the conversation she is performing the documentation task. The patient is an old man with light dementia. Lately, he has been falling and during the history taking, the doctor has difficulties finding out exactly what cause the patient most problems in his everyday life. He has been complaining about pains in his one leg and foot, but his GP, who has referred him to the ward, indicated other medical issues as primary; see figure 10.1 for an overview of the layout.

Figure 10.1: Overview of the setting: individual task performance

Irrespective of the GP's concern or the patient is right, the doctor needs to document the patient's concern in the record, and thus engage in dialogue to represent his narrative as best as possible. The way, the doctor chooses to achieve this goal is by relying on memory of previous history taking as she types on the keyboard. This strategy is commonly used, and does not conflict with procedures in the ward. While this documentation task requires her attention, she focuses exclusively on the writing-reading activity and turns her back to the patient. This orientation to the binary patient on the screen fits the analysis in 5.3.1 where another novice doctor prioritises the surrogate patient over the real patient.

Further, when the Polish philosopher, Alfred Korzybski stated that: "the map is not the territory" he referred to how scientists often mistake models of reality for reality itself (Korzybski, 1931). In this case, the doctor likewise mistakes or treats the surrogate patient - represented by medical measurements and written narratives in the electronic medical record – for the real patient who lies in bed next to the doctor.[33] This problem is not new, thus a current dilemma relates to how healthcare practitioners prioritise between interaction with the real biological patient and the iPatient (Verghese, 2008) or surrogate patient (see chapter 5.3.1):

[33] There are multiple cases identical with this one that show how the doctors are constrained by the electronic computer during the documentation task.

> iPatients are handily discussed (or "card-flipped") in the bunker, while the real patients keep the beds warm and ensure that the folders bearing their names stay alive on the computer. […] If one eschews the skilled and repeated examination of the real patient, then simple diagnoses and new developments are overlooked, while tests, consultations, and procedures that might not be needed are ordered. (Verghese, 2008:2749)

Thus, as the doctor completes the documentation task, her interaction with the patient dissolves. For 3 minutes and 31 seconds only silence appears on the sound track of the recordings. Thus silently she reads in the medical paper record, gazes at the screen or keys information into the system, just as the procedures order her to do (see figure 10.2).

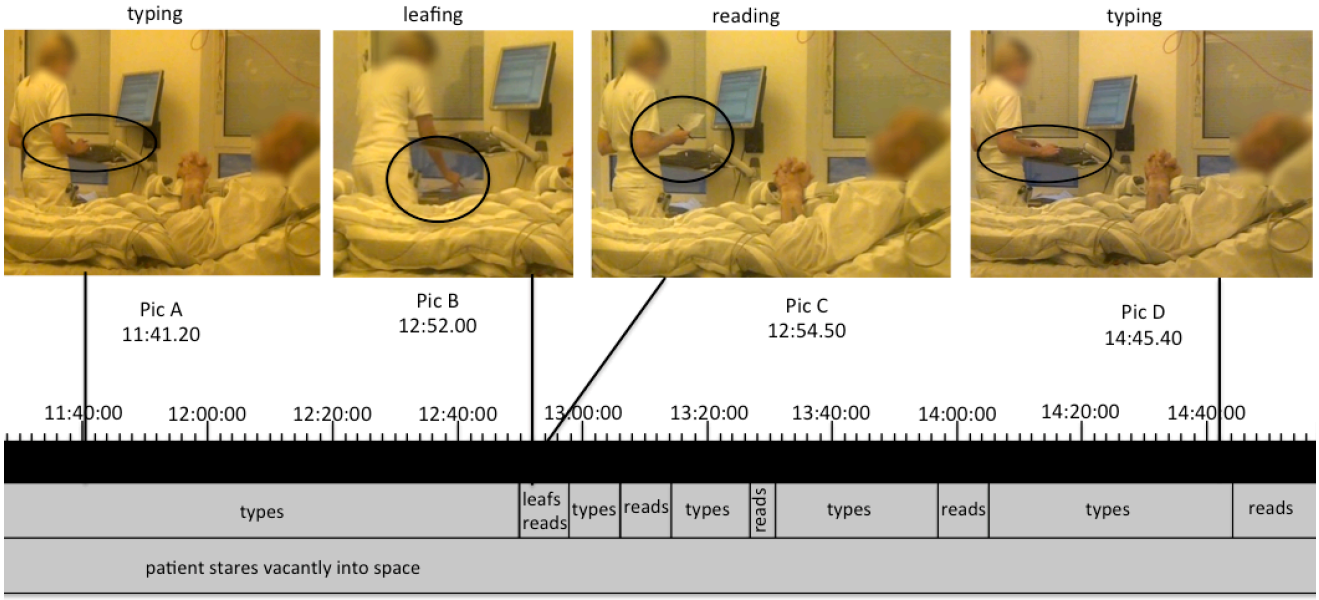


Figure 10.2: Monological behavioural trajectory

The figure represents the patient's 'silent' trajectory. As the doctor switches between reading in the papers and typing she completes the documentation task individually. The trajectory is representative for the overall task performance. Momentarily, she asks a question of clarification, and then continues to operate individually. Clarification happens on the basis of what the doctor needs to clarify. The patient then answers but does not know what the result of their interaction is, as the conclusions in the record remain unspecified to him.

In this excerpt, the silence becomes tangible. The doctor stands with her side towards the patient. The patient lies in bed and he is not part of the process and he is not informed about what is going on. From figure 10.2 no issues, problems or disruptions seem to emerge. No changes in the interactivity trajectory (for instance frustration, confusion, hesitation or the like) are detected. In other words, dysfunctionality does not seem to be experienced by the involved participants. The patient lies in bed with his hands clasped and stares vacantly into space. The four pictures (A-D) visualise the process from the beginning to the end of the excerpt. During the whole scenario, the patient does not change

his position at all.

The material organisation of the cognitive system narrows down the doctor's visual system, and inhibits her ability to perceive dynamics that are played out beyond the system's boundaries. She rarely uses gestures, as she does not interact with the patient. This approach is error-prone: for instance, it is mandatory that the healthcare wards document the anamnesis in a precise, standardised and scientific, medical terminology, thus, the doctor needs to translate the patient's explanations to a shared and established medical vocabulary, hence it can be valuable to engage the patient in this process. When the doctor bases documentation on information generated by electronic artefacts and memory of previous interactions, the patient is excluded from the part of the conclusion process. He is likely to lose the overview of what is being documented, and potential misunderstandings are not validated in the local situation. The doctor neither meshes tasks, nor does she use gestures. *How* to perform this task in an embodied manner has never been taught. Only the technical and procedural level of documentation: for instance how the software works and what should be documented etc. has been scrutinised in practice. However, nothing within the environment prompts the doctor to do so as no changes appear (no issues emerge). This 'problem free' trajectory underlines the importance of investigating actual task performance as well as what goes on beyond members' perspectives and phenomenological accounts of problems.

The doctor completes her job in accordance with overall procedures, but she reduces her scope of attention and demarcates the cognitive system from the patient, which collides with the general principles for dialogical task performance. In isolation, however, nothing critical is identified in relation to her task performance. However, it is argued that latent error cycles are more prevalent when the event trajectory reveals individual and monological documentation processes. By comparing silent and monological interactivity trajectories with dialogical modes of task completion, the quality of dialogical strategies becomes obvious. Thus, in the following, two cases of dialogical task performances are presented. Together they show why dialogical performance is important and effective for all parties involved.

10.3 Case II: voice and body dynamics as event markers

This case involves a young man who has just entered his thirties. He suffers from diabetes and he has lost both legs due to diabetes-related complications. He is a known patient with a complicated medical history. During the last couple of months he has been in and out of the hospital and this time he arrived by 911 due to severe chest pains. The doctor is an experienced primary doctor and after she has briefly examined the patient, she starts the documentation process. During the documentation process, the doctor also takes the patient's history and she meshes these two tasks. Compared to the first case, where the doctor relied on memory of the previous history taking process, this doctor performs all tasks simultaneously. This excerpt specifically pivots on how she, as she uses her tone of voice to explicate and demarcate different cognitive events, enables the patient to keep

track and gain knowledge about where in the process they are and how important the distinct processes are. The setting is illustrated below.

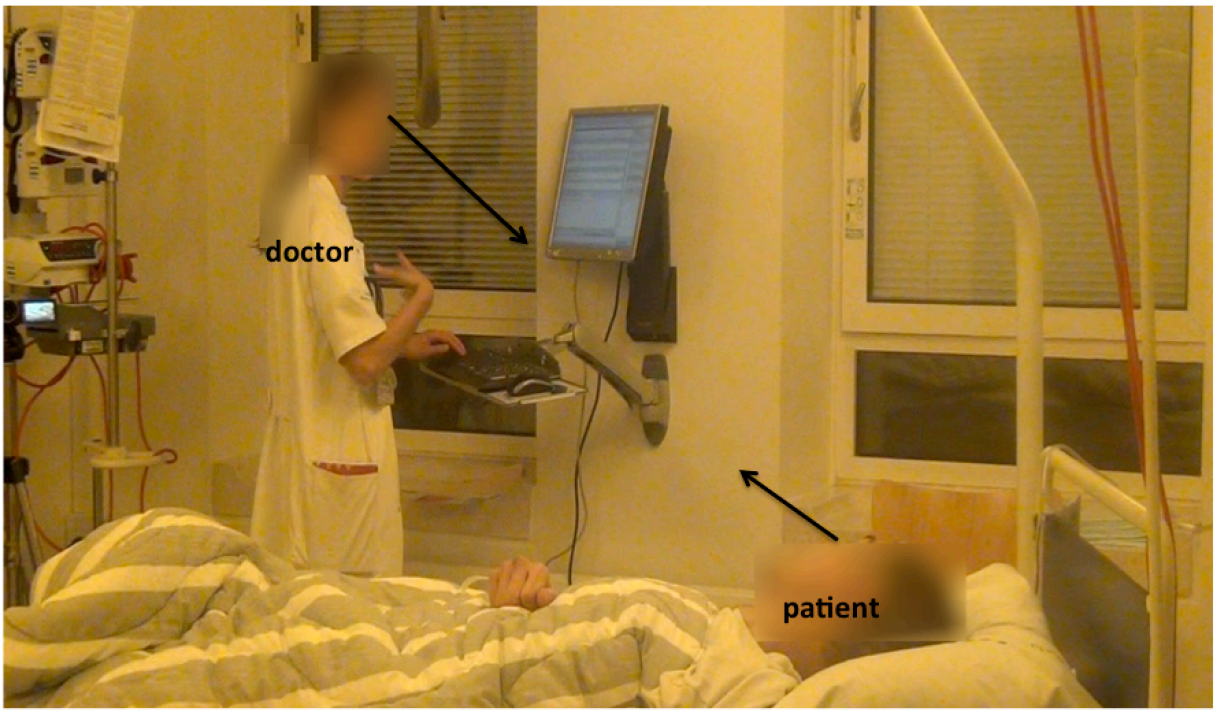


Figure 10.3: Overview of the layout: voice dynamics

The doctor is obliged to document information about the patient's broader life situation as well as particular illness-specific circumstances. These circumstances are explored through standard and general questions as well as more sensitive and context-specific questions. Generally, the doctors rarely make interactional distinctions between these types of questions (see chapter 6.3.1). This doctor, however, uses her tone of voice differently to indicate changes in types of questions, their relevance and the level of expected engagement. This vocal-based distinction is important since standard questions often seem either irrelevant, embarrassing or even silly from the patient's perspective (do you smoke?, are you pregnant?, do you drink alcohol on a daily basis?, do you suffer from headache? etc.) contrary to more particular and contextualised questions (where did the pain arise?, what did you do when the pain arose, how do you feel, are you scared etc.). Specifically, this doctor uses three different voice dynamics to demarcate the different status and function of her questions. Cowley (2011) emphasises how prosodic realisation intertwines with bodily coordination in general and leads to an overall utterance-activity: "At all times, however, *digital signalling* (Ross, 2004) is coordinated with bodily expression and prosody. In the resulting utterance-activity, vocal and non-verbal expression are integrated by bodies that adjust to an event in a cultural world" (Cowley, 2011:3). The three variations performed by the doctor are termed (*a*) truncated voice dynamics, (*b*) fluid voice dynamics, and (*c*) staccato voice dynamics. They are exemplified and discussed in the following.

Transcript 10.1

DANISH ORIGINAL

Excerpt 1
truncated voice dynamics

```
1. D:            synsforstyrrelser svimmelhed hovedpine
```

Excerpt 2
fluid voice dynamics

```
2. 09:10:60, D:  du kommer med 112 på baggrund af brystsmerter
3. 09:13:20, ps. (4.5) (P nods 'yes')
4. 09:17:70, D:  °°godt↓°°(.) fortæl mig hvad du lavede da du fik ondt i
brystet
```

Excerpt 3
staccato voice dynamics

```
5. D:            okay↓ (0.7) ø:h (0.5) så lignede (4.1) smerten i brystet
                 (1.1) fra sidste (0.8) indlæggelse (0.5) men værre
```

ENGLISH TRANSLATION

Excerpt 1
truncated voice dynamics

```
1. D:            visual disturbances dizziness headache
```

Excerpt 2
fluid voice dynamics

```
2. 09:10:60, D:    you arrived by 911 because of chest pains
3. 09:13:20, ps.   (4.5) (P nods 'yes')
4. 09:17:70, D:    °°okay↓°°(.) tell me what you did as the chest pains came
```

Excerpt 3
staccato voice dynamics

```
3. D:            okay↓ (0.7) e:h (0.5) so similar (4.1) to the pain in the chest
                 (1.1) from the last (0.8) hospitalisation (0.5) but worse
```

The three different voice dynamics relate to different interaction strategies that facilitate task achievement in a dialogically efficient way. These strategies enable the doctor (*a*) to get brief and summarised information, (*b*) to allow the patient to elaborate on specific elements in the narrative, and (*c*) to explicate conclusions as final outputs in the record. Further, these vocal dynamics relate to variations of syntax, linguistic content and contextualisation. All the voice dynamics mark an event type with a specific function. With truncated voice dynamics, the doctor is able to cut off unnecessary information around the keywords she needs the patient to respond to. Due to the context, the doctor is able to comprise three questions into one verbal utterance, and thus she avoids constructing complete sentences as: *did you suffer from visual disturbances*?, for instance. By uttering single nouns, her utterance is succinct and articulated in a monotone voice rhythm. Using elliptic sentences – or basically single words – allows her to mark the activity as distinct from the rest of the interactivity. In this case, she demarcates the function of standard questions from more emotional and personal questions that are not situationally relevant. Indeed, these questions are needed, but she briefly goes through them with a minimum of elaboration. Because the patient treats the questions in a row as affordances for short answers as 'yes' or 'no', the doctor and the patient perform in an efficient and coordinated fashion. The doctor implicitly hints at the 'obligatory bureaucracy' as she utters these words rapidly and with a monotone voice. Moreover, her tone of voice, her economical use of relevant words, her body position towards the screen and her strict invitation for short answers make her appear efficient, authoritative and concise. Consequently, the doctor saves time and completes this nested task efficiently together with the patient as she elegantly prioritises her time and the patient's needs in relation to the overall goal: coming up with a diagnosis.

While the doctor appeared straightforward and concise in the case of truncated articulations, she appears differently engaged and dialogical when it comes to other types of questions. For instance, when the doctor needs elaborated and particular information that requires the patient to contextualise information, she uses a narrative strategy that prompts the patient to engage in dialogue: *you arrived by 911 because of chest pains (4.5) °°okay↓°°(.) tell me what you did as the chest pains came* (excerpt 2, line 2+4). The doctor's dialogical structure affords a contextualised and detailed answer. Further, the tempo is slowed down and the voice dynamic is more melodious, fluid and soothing compared to the previous example. As such the doctor indicates that this part in interaction has another status, function and priority. Compared to other situations, doctors often initiate history taking with the broad question: *tell me what happened?* In this situation, the doctor creates the start herself: *you arrived by 911* (excerpt 2, line 2). This strategy saves time and contextualises her state of thought as well as marks the specific part of the patient's narrative, she wants him to elaborate: *tell me what you did as the chest pains came* (excerpt 2, line 4). The doctor keeps focus on the screen until the end of her utterance, and as she then gazes at the patient she further marks a transition-relevance place (Sacks et al., 1974) in the dialogue where the patient is expected to contribute. This approach entails an efficient information elicitation that is characterised by confident prioritising that makes it easy for the patient to follow the flow throughout the event.

Finally, the doctor enacts a third voice dynamics pattern that makes the patient aware of how her interpretation of the patient's narrative is documented in the record. As she keys in the information she utters in a staccato-like tone of voice what she writes. There is, however, a delay between the moment she utters something and the text appearing on the screen, which momentarily causes her to pause at syntactically unusual places: *so similar (4.1) to the pain in the chest (1.1) from the last (0.8) hospitalisation (0.5) but worse* (excerpt 3). This reading-aloud-strategy keeps the patient part of interactivity, and by explicating the cognitive task, the patient becomes aware of each step within the process. Furthermore, as the doctor marks the shift in the process, especially through her prosody, the patient performs his role as patient differently by shifting between contributing to the process and fading into the background. The doctor thus relies on her embodied resources in a way that enables completion of multiple tasks. Particularly, she writes while she utters *what* she writes and as such she is able to maintain the interpersonal relationship with the patient. The patient, in turn, is able to sanction or reject the doctor's conclusions, as he knows exactly how the doctor interprets their dialogue. Thus writing and documentation is meshed with summarising for the patient so that at no time do they break down the joint cognitive system.

All three voice dynamics (truncated, fluid and staccato) are unique forms of embodied behaviour that mark shifts between distinct events with different functions during history taking and documentation. The dynamics enable the patient to distinguish between different purposes and elements during these nested tasks. This doctor, who has a long record as a professional in the ward, has developed an expertise, which enables her to prioritise easily *in situ* and deal with multiple issues all at once. The doctor's capabilities for enacting various vocal dynamics are related to her skilled expertise: "Utterance-activity arises as we make and track phonetic gestures (Fowler, 2010) that prompt us to hear utterance types. Using different time-scales, rich linguistic memory evokes experience (Port, 2010) that gives wording a particular sense" (Cowley, 2011:4ff). The doctor enacts different vocal and non-verbal behaviours as she knows how the different forms of behaviour, each in their own way, enable and constrain task performance. As she knows what is relevant to do, her whole-bodied actions can be interpreted as a way of integrating slow sociocultural processes with fast real-time coordination. Based on her general non-situated understanding of best practice, she performs and adjusts her voice dynamics in relation to the patient's actions. Thus, with an ecological perspective on language (Cowley, 2011; Hodges, 2007a; Fowler, 2010; Thibault, 2011; Steffensen, 2011), the functional outcome of language is a result of the doctor's history of embodied coordination (her skilled behaviour) meshed with the patient's capabilities for local interaction. The functional result emerges, as the non-local is coordinated locally.

10.4 Case III: gestures as cognitive resources

This case involves an elderly female patient with a complicated medical history and during this hospitalisation she is specifically troubled with abdominal issues and she has suffered from rectal bleeding amongst other serious complications. Her husband sits at the end of the

bed. The doctor is a novice, but in contrast to most other novices, he does not use pen and paper during history taking. In this excerpt he uses his body to facilitate sense-making for both patient and himself.

Transcript 10.2
Duration: 02:23:40 minutes

DANISH ORIGINAL

```
1.  06:00:00, P:   jo ja: det gør ondt nu går det jo ned og så går det op her
2.  06:58:40, ps.  (0.6)
3.  06:59:00, D:   op der
4.  06:59:60, P:   ja
5.  07:00:10, D:   okay=
6.  07:00:60, P:   =jeg er lidt øm
7.  07:01:80, D:   der er du lidt øm (.)
(xxx)
8.  07:51:60, D:   godt↓ (.) så hvis vi nu tager det hele engang her [altså
                   igennem 14 dage har du haft opkastninger [(.) i forbindelse med
                   at du sådan har rejst dig (.) og det kommer en gang imellem
                   nogen gange er det der [nogen gange er det der [ikke (.) ja↓ så
                   har du været utilpas (.)
9.  07:00:00, P:                                                          [ja
                                                                [ja
                                                 [ja                [ja
10. 08:01:40, P:   ja (.)
11. 08:02:10, D:   og så har du haft sådan tiltagende af maveomfang [(.) dels så
                   var du lidt stø[rre (.) og dine ben er også [hævet op
12. 08:04:50, P:                                                      [ja
                                [ja                          [ja
13. 08:07:10, D:   og så samtidig så er det blevet lidt værre med din åndenød som
                   du [ellers har haft igennem mange år
14. 08:09:50, P:      [ja
15. 08:11:00, P:   ja (.) det er altså at så skal jeg ligge mig ned [al
16. 08:13:40, D:   [ja (.) og du har ikke haft feber (.) og du fik så fat i
                   vagtlægen i dag som valgte at indlægge dig
17. 08:17:80, P:   ja
18. 08:18:60, D:   o::g hvad hedder det du har ikke sådan decideret mavesmerter
                   men der sidder sådan lidt noget der sådan kravler lidt i benene
                   [og lidt op mod læ[nden herop
19. 08:23:20, P:   [ja               [ja herop
```

ENGLISH TRANSLATION

```
1.  06:00:00, P:   yes ye:s it hurts now it runs down and then it moves up here
2.  06:58:40, ps.  (0.6)
3.  06:59:00, D:   up there
4.  06:59:60, P:   yes
5.  07:00:10, D:   okay=
6.  07:00:60, P:   =I am a bit sore
7.  07:01:80, D:   there you are a bit sore (.)
(xxx)
```

8. 07:51:60, D: okay↓ (.) so if we go through it all now [well over the last 14 days you have been sick [(.) when you kind of got up on your feet (.) and it emerges now and then [sometimes it is there sometimes it is [not yes↓ then you have been unwell (.)
9. 07:53:70, P: [yes [yes [yes [yes
10. 08:01:40, P: yes (.)
11. 08:02:10, D: and then your stomach began to distend [(.) partly you were a bit big[ger (.) and your legs are [swollen up too
12. 08:04:50, P: [yes [yes [yes
13. 08:07:10, D: and then at the same time it has become a bit worse with your breathing difficulty which you [actually have had for many years
14. 08:09:50, P: [yes
15. 08:11:00, P: yes (.) well it is that then I need to lay down [al
16. 08:13:40, D: [yes (.) and you did not have any fever (.) and then today you got hold of the doctor from the emergency services who chose to hospitalise you
17. 08:17:80, P: yes
18. 08:18:60, D: a::nd well you do not have stomach pain per se but you fell as is something is kind of crawling around in your legs [and a bit towards the small of your [back around here
19. 08:23:20, P: [yes [yes around here

The doctor switches constantly between history taking and documentation, rather than completing one task at a time as in case I. The interactivity is iterative and characterised by loops of asking for information, keying into the system, asking for information, keying into the system, seeking clarification etc. During this process, the patient is not left alone for longer periods of time and when the doctor interacts with the patient, he steps away from the computer and faces the patient. This physical orientation allows him to engage in dialogue without being constrained by the materiality of the computer. In the previous case, the doctor meshes the two tasks but, in turn, she becomes attached to the computer in a way that constrains her flexibility bodily; for instance as she places her hands on the keyboard when she asks questions so that she is ready to document the answer immediately.

In this medical encounter the novice doctor has initiated the history taking and he asks the patient to locate and describe her pains. The patient uses her left hand to indicate the exact extension of the pain on the right side of her body (see picture A).

Pic A: 06:58:00
l.1, P: it moves up here

Pic B: 07:03:00
l.7, D: a bit sore (.)

The doctor gazes, not at the patient's face but at her gesturering. The doctor then seems surprised by the patient's vocal and gestural location of her pains and he repeats the utterance as he puts emphasis on *there* (line 3). Four seconds after the patient has located the area of pain, the doctor replies to this utterance and a brief pause emerges as he touches his own body similar to the place where the patient has indicated her pain area in line 1 (see picture B).

The doctor and the patient engage in joint sense-making as they come up with a shared understanding of pain location as they coordinate inter-bodily dynamics *in situ*. The doctor appears intrigued by the perceived pain area, and he starts to simulate the patient's embodied movements to localise the pain area through (physical) self-touch. Rather than relying on verbal questions or observations alone, the doctor inhabits and learns about the patient's world (Streeck, 2010). This means that what he gains from observing the patient's localisation of pain and the value he gains from asking her to describe the pain area is different from what he gains from self-touch. Further, as the patient touches her right side, the doctor touches his right side and as they observe each other's interdependent self-touching gestures, they jointly adjust their movements and make sense of where the pain is located. Thus, they do not use gestures as a means for information processing or expression, rather, as they coordinate their gestures, meaning emerges from that coordinating behaviour:

> Rather than perceiving gestures as part of language, an ecological perspective is proposed […] This broader account of gesture requires a different conception of the human body than is commonly presupposed by researchers of "non-verbal communication": a model of the body not as an instrument of expression, but as a skilled (knowing) inhabitant of worlds. (Streeck, 2010:223)

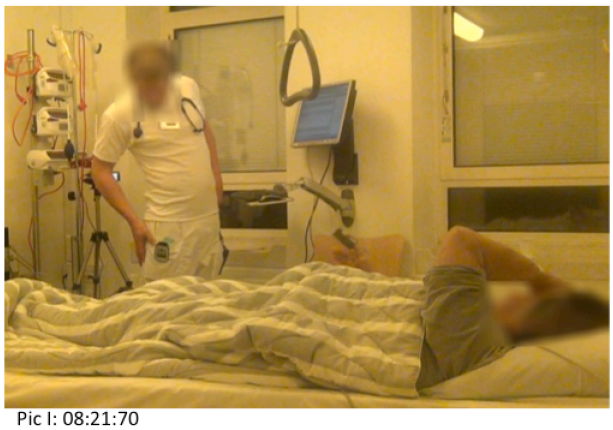
In Streeck's view, an ecological account of gestures treats gestures as: "symbolic body action evolved from the body's practical engagement with the world" (Streeck, 2011:237). While he emphasises the importance of the cognitive and embodied aspect of gestures, he remains focused on how the gesturer contributes to the organisation of interaction by anticipating the *next moment* (Streeck, 2011:225). As his ecological perspective is a valuable

contribution to conventional multimodal studies, his heuristic of ecologically different modes of gesturing (Streeck, 2011:226) could be expanded with a focus on how whole-bodied interactivity contributes to joint sense-making (Linell, 2009; 2015). With the interactivity-based framework, the ecology of gestures requires an analytical focus on coaction beyond sequences of gesturing. As shown above, the doctor and the patient come closer to a shared understanding of pain location as a result of their embodied co-articulation (Thibault, 2014).

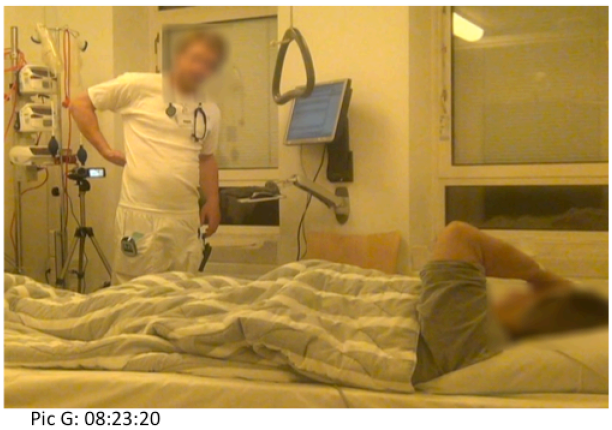
After the doctor has asked extensive clarifying questions, he summarises the patient's narrative in a rather extraordinary fashion. By relying just as much on his non-verbal resources as medical categories during this process, he explicitly shows and tells how he interprets their joint construction of the patient's narrative. By so doing, he integrates two domains: the objective medical domain and the subjective patient domain. Further, as he wraps up the patient's narrative, his gestures prompt the patient to keep focused on the narrative and recall memory in relation to body parts and pain areas in a way that verbal utterances alone cannot do.

Pic G: 08:08:90
l.13, D: a bit worse with your breathing difficulty

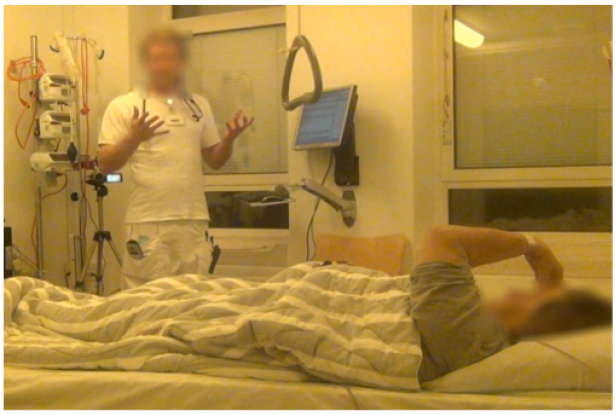
Pic H: 08:20:20
l.18, D: you do not have stomach pains per se



Pic I: 08:21:70
l.18, D: something is kind of crawling around in your legs



Pic G: 08:23:20
l.18, D: towards the small of your [back around here



Pic C: 07:56:70
l.8, D: got up on your feet

Pic D: 08:03:50
l.11, D: your stomach began to distend

Pic E: 08:04:00
l.11, D: your stomach began to distend

Pic F: 08:06:50
l.11, D: your legs are [swollen up too

The doctor's embodied actions constitute a cognitive activity of which the patient is part. The patient replies to how the doctor *enacts* the movement of pain within a given body area; for instance the stomach (see picture H), the lumbar area (see picture G) etc. The gestures enable a shared understanding and validation of the medical symptoms and their locations. The doctor refers to specific physical places that become visible in a here-and-now context. For instance, as the doctor utters: *towards the small of your [back around here* (line 18), he determines the exact boundary between the lower ribs, the hip bones and the lumbar area, which can be a difficult task for the average patient. Thus, in this case, the doctor's gestures function as a kind of bodily indexicality that easily prompts the patient to recall memory and approve the embodied narrative. The direct relationship between the location of the patient's symptoms and her experienced pain and the pointing towards the area on the doctor's body scaffolds the patient's memory. The real-time embodiment in a local visual domain are linked to her non-local perceptions. Besides, pain, which is felt bodily, is easy to locate visually since the precise area can be pointed to or a feeling can be acted out (e.g. breathing pattern). Words, on the contrary, are poor for describing symptoms and pain areas in detail: For instance, when relying primarily on words in such tasks, the margin of error increases as misunderstandings are often related to the superficial power of verbal categorisation. With words, we can only represent areas or parts of the body as e.g. the lumbar *area* or the *small*

of the back. Alternatively, in this context, the costs of uttering a precise verbal description are too high. It takes time to explain where in the lumbar area the pain is located, or where in your back, leg, foot etc. you have perceived the symptoms. Hence, in such situations gestures can locate the pain more comprehensively and unambiguously than words within the same time.

This example illustrates how the doctor and the patient co-act and adapt to the shifts in the cognitive system: for instance when the doctor adjusts his perception of the patient's pain area as she shows where she felt the pain. Gestures are important affordances for effective and dialogical problem finding and problem-solving. The profound use of gestures in this interactivity is unique and within the coding I have not been able to document similar examples of such systematic and dynamic use of gestures. The embodied actions affect outcome successfully and the result is achieved much faster compared to situations where the history taking activity is achieved by prioritising verbal interaction.

10.5 Conclusion: the need for external success criteria in the assessment of task performance

Overall, from the analyses of the three interactivity trajectories, the function of embodiment is exemplified. In order to integrate two different cognitive tasks of typing and dialogue in documentation requires a whole-bodied creative strategy, which enhances understanding, precision and patient involvement. It is argued, that the enabling conditions of nested task performance lies in the ability to integrate different cognitive activities through rich embodiment.

In the first case, a static and monological trajectory inhibits dialogical sense-making and shared coaction, which potentially can lead to misunderstanding or even human error. The doctor switches between typing and reading and she interacts with the electronic artefact without being aware of what the patient knows or feels. Paradoxically, the doctor completes the task in accordance with protocols for documentation, but as the situation is compared to alternative strategies of performing this task, her individual-based approach seems unapt for optimal task performance. In the second case, the doctor meshes two tasks as she multi-performs. Her variation in voice dynamics enables an ongoing interaction with the patient when, at the same time, she completes the task of documentation. "Interaction […] is never 'about' one level of context […] Rather, it is simultaneously 'about' all of the scales of embodied context the participants bring to bear during the interaction. Embodied action (including speech) always contributes to the sustaining of multiple nested contexts at once" (Streeck and Jordan, 2009:454). Even though, Streeck and Jordan separate interaction into various modalities, they focus on how an activity: "is one of fluid, multi-scale, joint sustainment *in multiple context simultaneously*" (Streeck, 2010:239). Thus, in the second excerpt the doctor's historically developed expertise is played out in different situated voice dynamics that has an organising effect on local information gathering. Further, the various voice dynamics enable her to mesh the tasks without letting the computer become the locus of interest. As she keys information into the system, she

quickly ‘returns’ to the patient again and gazes at him, asks more information etc. However, as she does not stray from the computer, the enabling conditions for flexible and dynamical gesturing are partly constrained. In the third case, the doctor meshes the tasks of history taking and documentation, but he does not perform them simultaneously. He moves in and out of the two different activities. When he engages in history taking he relocates and moves towards the patient. As he does so he is able to adapt flexibly to the situation. When he perceives changes in the patient’s behavioural pattern he adapts to these changes. For instance, he simulates the patient’s gestures and gains a new insight about the patient’s symptoms. Further, as the patient shows, feels and visually perceives her medical narrative in the situation, the doctor and the patient jointly make sense of their shared coaction: they co-act by attuning their gestures in interactivity. The result is precise, effective and dialogical task performance. Gestures appeared to have a valuable coordinative function in interactivity. Interactivity enabled the doctor and the patient to co-articulate a functional outcome based on reciprocal embodied behaviour. Moreover, gestures served as negative feedback mechanisms that ensure corrections are made and understandings are perceived within the local system. Finally, gestures have an important function in the enactment of non-local perceptions in real-time interaction as areas of pain were identified via self-initiated touch and via perception of the other’s self-initiated touch.

Because various documentation task performances have never been compared, and as negative task results are not immediately perceived, the task baseline is difficult to identify. When the negative outcome remains absent – for instance when the patient does not complain and the task is completed in accordance with standard procedures – no issues are experienced by the practitioners *in situ*.

The documentation task includes dual cognitive processes that, optimally, are integrated in a dialogical way. When the iPatient is prioritised over interaction with the real patient, the task performance is often managed individually. Individual-based documentation impedes the integration of the two cognitively distinct processes (typing and dialogue) as it affords the practitioner to engage in documentation activity based on doctor-artefact interaction. Individual-based trajectories are not necessarily related to dysfunctionality or erroneous outcome *per se*. But, such patterns are more likely to cause interpersonal breakdowns, unnecessary frustration amongst patients and relatives, and to minimise recognition of what has been documented. Further, the possibility for misunderstanding, and consequently human error increases as the tacit conclusions serve as positive feedback-mechanisms: when the doctor’s interpretations and conclusions are not validated, nothing causes the practitioner to adjust what he or she is doing. However, in cases where the doctor utters an interpretation, such explication serves as a negative feedback mechanism as the patient is able to adjust, acknowledge or reject the outcome, so clarifications can be made *in situ*.

Finally, understanding the ontological difference between speech and writing is crucial for the design of aiding tools in the documentation process. Thus, the dialogical intentions built into the electronic device must be related to the challenge of balancing the two distinct processes of typing and dialogue with the patient during the overall documentation

process. While the computer itself does not intend anything, its physical location in the room and the way it becomes a central component of the cognitive system makes it afford a behaviour that easily constrains intended dialogue in situations where the practitioner is less skilled and therefore less able to prioritise and integrate the patient in the process.

11. Conclusions and future perspectives

> Many of the foundational problems of cognitive science are consequences of our ignorance of the nature of cognition in the wild […] The first part of the job is, therefore, a descriptive enterprise. I call this description of the cognitive task world a "cognitive ethnography." One might have assumed that cognitive anthropology would have made this sort of work its centerpiece. It has not. *Studying cognition in the wild is difficult, and the outcomes are uncertain*.
>
> - Edwin Hutchins (1995a:370ff; my emphasis)

11.1 An ecological approach: from interaction to interactivity and from errors to error cycles

This final chapter summarises the main findings and discusses the insights of the dissertation as it provides an answer to its research questions. It discusses how the empirical results of the dissertation will give rise to future projects within the field. Finally, it discusses the opportunities for making an impact on the humanities and the cognitive sciences.

The aim of this qualitative investigation of human error cycles in medical diagnostic processes was to provide evidence for the need to deal with multiple timescales in a way that yields new interdisciplinary and analytical methods. In the first pages of this dissertation, I argued that mainstream models of human errors, interaction and cognition were unapt for describing and explaining how error cycles relate to human interactivity in emergency medicine beyond a representational state of cognitive analysis and beyond a micro-sociological perspective on language in interaction. I proposed an alternative

ecological approach that takes a different starting point than the above-mentioned approaches as it investigates the cognitive ecology of human errors by turning to the dynamics of cognitive ecosystems (Hodges and Baron, 1992; Hutchins, 2014) in emergency medicine. Similarly, Gibson argued that an ecological approach to visual perception, contrary to standard approaches within this field "works from the opposite end. It begins with the flowing array of the observer who walks from one vista to another, moves around an object of interest" (Gibson, 1979/86:303). In line with Gibson, this project extends the object of investigation, not only in space but also in time. An ecological approach prioritises interactivity as it pivots on how local coordination is sense-saturated (Steffensen, 2013). From this perspective, the slow dynamics of sociocultural coordination mesh with the fast, situated coordinative inter-bodily dynamics. Finally, an ecological approach to human error entails a focus on error cycles rather than negative outcomes in isolation. By so doing, it becomes relevant to identify the feedback mechanisms within a cognitive ecosystem and how these mechanisms either intensify errors and result in a system's breakdown, or how they are encountered in a way that leads to recalibration within the system.

Having outlined the shortcomings of existing approaches to the study of human error, language and cognition, I presented an alternative interactivity-based framework used in the investigation of the following research questions:

How do healthcare practitioners manage cognitive events in patient diagnosis and treatment in a way that yields cognitive results?

(i) How do healthcare practitioners anticipate and counter errors? How does an emergency medical team function to prevent errors in complex diagnostic situations? How do errors emerge and escalate in a (dys)functional social system?

(ii) How does medical culture affect real-time interaction and how is the culture itself shaped by the exact same dynamics?

(iii) What are the methodological innovations that can be extrapolated from an ecological perspective on human errors and an ecological approach to language and cognition?

The overall conclusion is that an ecological approach is apt for explaining how events on multiple timescales affect cognition in complex organisations. By extending practitioners' behaviour to an ecosystemic activity, cognitive results are shaped by non-local dynamics and situational affordances for actions within the cognitive system. This conclusion is based on a cognitive ethnographic study. In line with Hutchins' recommendations, I conducted a cognitive ethnographic study to gain a deeper understanding of the enabling conditions for cognitive events in emergency medicine. Such understanding, I argued, is the prerequisite for enhancing healthcare practices and eventually reduce the amount of interaction-based error cycles. In this dissertation I have tried to qualify an account of human interactivity that enables investigations of how the non-local shapes the local and

vice versa. Based on video-recordings of 17 real-life diagnostic and treatment situations at the emergency ward at a Danish hospital, I used multiple excerpts to exemplify exactly how practitioners manage cognitive events in a way that yields results.

The dissertation's empirical findings are specific examples of how the multi-scalarity of human cognition in emergency medicine relates to human errors and successes. It shows what form non-local dynamics and situational affordances for action take in real-life, (dys)functional diagnostic events. These empirical findings are summarised below.

11.2 Empirical findings

In this section I briefly summarise the outcomes of the analytical chapters before I synthesise the results in three topics that invite further attention. To understand the nature of human errors, I investigated the enabling conditions of medical functional and dysfunctional interactivity trajectories in their ecological settings. I argued against a traditional error taxonomy that identifies errors in relation to negative outcomes. Instead I proposed thinking in terms of error cycles where multiple feedback-mechanisms can be identified and, depending on how they are managed, prevent an erroneous outcome. As such, the dynamical feedback mechanisms (positive and negative) enrich our understanding of why and how healthcare practitioners are able to solve problems or become fixated. The dissertation argues that, at an overall level, such understanding of the ecology of human cognition can be used to enhance practices. Thus rather than looking for human errors, I investigated how *cognitive events* were managed in naturalistic settings as healthcare practitioners relied on expertise, team members, patients and environmental circumstances. From analyses of (potential) error cycles and, more generally, how practitioners undertake treatment as a team-based problem-solving activity, each chapter focuses on a thematic aspect related to the systemic function of cognitive behaviour: (*a*) medical visual systems; (*b*) interruptions; (*c*) diagnostic procedures; (*d*) medical cultural dynamics; (*e*) sense-making in teams and (*f*) writing the electronic medical record. The analyses demonstrate how team members enact expertise-in-action, and also how lack of coordination and communication can lead to human errors. In particular, it shows that non-routine events are crucial to what goes on in the emergency ward: anomalous events function as affordances and trigger feedback mechanisms which prompt team members to anticipate possible changes of plans.

In particular, chapter 5 investigates how problem finding and problem-solving are constrained by medical visual systems. By relating Goodwin's (1994) 'professional vision' to Gibson's (1979/86) 'visual system,' I show how perception is embedded in an extended space-time. Specifically, the chapter demonstrates how a visual system depends on local coaction and non-local events (cf. Steffensen and Cowley, 2010), such as for instance practitioners' experiences from medical school, and the sociocultural practice that is embedded and incarnated in medical tools and artefacts. Further by showing how action and perception are interrelated and dynamical phenomena, being in the right place in diagnostic situations is a continuous process of adapting to changes in the environment.

Moving around defines the nature of visual perception: experienced and skilled practitioners' movements are sense-saturated, which provide them with an extended and functional perceptual system that enables them to perceive and anticipate potential error cycles in small-scale changes that they can act upon immediately in order to recalibrate the system. Finally, the chapter pointed to the function of artefacts in relation to visual perception. Depending on the practitioner's level of adaptive flexibility, the materiality of the environment either constrains or expands a professional visual system. Thus, by taking the visual system into consideration it becomes possible to expand the understanding of how practitioners' perceptions are enabled: How they feel, what they see, and what they think are results of how they are educated, what procedures they are taught and to what extend they are able to integrate that knowledge and experience with what happens in situations: e.g. what a patient narrates, how team members act and how they cope with the unexpected. In practice, the key is in understanding how the local environment can be designed and investigated in a way that gives practitioners best possibilities for flexible adaptive behaviour. This challenge relates to the function of e.g. artefacts and procedures for local action, something that is investigated in chapter 6.

Chapter 6 scrutinises the function of standard procedures and protocols in (dys)functional cognitive processes. It shows how abstract and material aiding tools both constrain and facilitate cognitive solutions. The function of protocols depends on how flexibly the healthcare practitioner manages to balance diverging and multiple expectations for proper behaviour. By applying, in particular, Hodges' theory of values realisation, I show how, in some cases, healthcare practitioners are forced to replace a task heterarchy with a rule-following hierarchy by prioritising standard procedures over local demands for interaction. While procedures are necessary and relevant in the guidance of proper behaviour, they work like *models* for proper behaviour and they are a result of a written language bias (Linell, 2005). As the procedures focus on what to say and do in a fixed order, flexibility depends on the practitioner's capability to handle the procedures creatively in the local situation. From a design or educational perspective, protocols need to be designed to structure activities, while allowing freedom to be incorporated in situated interaction. Novices seem constrained by the slavish sequentiality provided by such aiding tools. How to coordinate diagnosis flexibly in the local is identified in skilled practitioners' ability for meshing tasks, relying on embodiment and applying material artefacts when needed in the situation. This insight is crucial for how procedures should be taught and developed in the ward.

In chapter 7 the frequent occurrence and function of interruptions in the ward are scrutinised further. The chapter focuses on the process of interruptions and the strategies for managing them. The problem with interruptions seems to be less about task-resumption or memory failure than about balancing expectations for proper behaviour. As interruptions emerge, I show how the practitioner either handles the interruption in a way that impedes the interpersonal relationship with the patient or declines the organisation's expectations for immediate response. Alternatively to this behaviour, skilled practitioners are able to meet multiple expectations all at once. Crucial to functional interruption-management is

the understanding of how team performance allows for multi-task performance in a way that enables the system to realise multiple and constraining values simultaneously. Thus, by relying on the medical team as one cognitive system, multiple nested activities can be completed simultaneously without disturbing situated interaction. This coordinative behaviour naturally serves as negative feedback that reduces the risk for latent error cycles and enhances dialogical coaction.

Drawing on the theory of values-realisation, chapter 8 investigates the power of cultural dynamics in situated interactivity and at the same time how culture is shaped by embodied behaviour. It investigates how sociocultural dynamics provide practitioners with a shared understanding of work procedures in a way that both scaffolds standardised performance and constrains functional sense-making *in situ*. Specifically, the chapter investigates cultural issues related to the emotional alliance and role hierarchies and it shows how such cultural issues are enacted in local interactions and lead to the emergence of error cycles. Moreover, it shows how practitioners to some extent act in accordance with a biomedical model that affects local coordination as some practitioners avoid patient initiated emotional contact. Further, it scrutinises the paradox that role hierarchies are maintained and reproduced just as much by the inferior in that hierarchy as the authoritative agent. Cultural patterns are embedded in local action as the practitioners embody their historical knowledge in interaction. Thus through inter-bodily dynamics, practitioners coordinate as the slower timescales are enacted in the local. By so doing, the articulated performance shapes future actions. Finally, the analytical results diverge from how the practitioners experience their own task performances. By bringing these two conclusions together it could be possible to change cultural issues strategically to minimise constraints on functional cognitive activities.

Chapter 9 demonstrates the benefits of thinking of a team as one cognitive system whose sense-making qualities are different from those of individuals. Analyses beyond the micro-sociological scales reveal the dynamics of distributed cognition and distributed language. Further by turning to inter-bodily dynamics, the analyses demonstrate how non-local experience is linked with local sense-making afforded by various team compositions in a way that can serve as anticipatory problem-solving. Further, this chapter underlines the learning potential for novices that work in experienced teams. As they depend on the team's experience, they learn from relying on second-hand perceptions *in situ*. Finally, the interactivity-based approach shows how cognitive processes are distributed action-perception cycles that often lead to problem-solving prior to problem identification and understanding. Thus, rather than reacting to dysfunctional performances alone, encouraging to creative learning attitudes of dedicated practitioners is another way of enhancing safe and dialogical work practices.

The final chapter investigates the joint sense-making capabilities of rich embodied behaviour during a specific task performance: documentation in the electronic medical record. The chapter further scrutinises the nested activities, (writing and speech), embedded in this task centred around a computer. By showing how the material artefact, the computer, and the complexity of integrating two ontologically different cognitive tasks

constrain adaptive flexible behaviour, and lead to monological task performance, it also demonstrates skill-based alternatives that enable the practitioners to maintain a dialogue with the patient while documenting in the record simultaneously.

Through numerous empirical analyses of how practitioners manage cognitive events, it becomes evident that the concept of multiple timescales is crucial to understand the enabling conditions of human cognition. Each chapter provides insights into *how* interactivity enables practitioners to manage cognitive events in different settings related to different tasks, different levels of skill, different team constellations and different medical scenarios. By extending practitioners' cognition to an ecosystemic activity, cognitive results are shaped by non-local dynamics and situational affordances for actions within the cognitive system. Each chapter, thus, focuses on a thematic aspect related to the systemic function of cognitive activities, e.g. decision-making, and together, a mix of task-related challenges (interruptions, history-taking, documentation etc.) and more general qualities and constraints of interactivity (the function of embodiments, the workings of visual systems, the role of an artefact-rich environment etc.) were investigated.

Several chapters overlap and supplement each other. When comparisons are made between the chapters, the particularities cluster in patterns. A common element unites the chapters and enable a general understanding of the underlying conditions for human error cycles: each chapter shows, that when practitioners are unable to balance the non-local and local constraints within the system, they fixate on one thing that increases the risk of the emergence of error cycles and when practitioners are capable of balancing non-local and local constraints within the system, they are able to adapt flexibly to changes in the environment and anticipate what comes next.

11.3 Practical implications and improvement measures

With a focus on cognitive events and human error cycles, some issues are specifically profound across the analyses. For instance a profound difference in novice and expert behaviour was identified and was explained as distinct capabilities to draw successfully on interactivity. In that process, the function and role of teams, artefacts and procedures were important affordances that served to scaffold functional and dialogical task performance.

Based on these findings, a synthesis of the empirical results forms the basis for a description of their practical implications. I propose three initiatives for healthcare practitioners to work with in order to enhance practice. As the design and development of intervention strategies and training programmes are not central for my project, I only briefly reflect on how such initiatives could have an impact on future practical interventions and general challenges in everyday work practice. These initiatives relate to (*a*) the implementation of a new model of language and cognition in the field, (*b*) changing the basic assumptions of what is relevant content in training programmes and (*c*) dealing with (the design of) material artefacts as flexible *artefact environments*. These three themes are discussed below.

11.3.1. The interactivity turn in emergency medicine

Like other studies, my findings indicate that adverse events are related to behavioural and non-technical aspects of performance (Yule et al., 2006; Flin and Maran, 2004). Within the literature on non-technical skills (e.g. Yule et al., 2006; Flin and Maran, 2004), there has been a dawning realisation that such skills should be investigated further since human errors are rarely related to technical skills. As a result of this tendency many training programmes focus on such non-technical skills, but they do so in a rather conventional way that does not correlate with how non-technical skills are developed and used in real-life. This claim has consequences on multiple parameters. First, non-technical skills are separated into multiple demarcated activities. Such distinction originates in a dualist model that separates cognition from communication; for instance when cognitive skills (e.g. decision-making) are separated from other interpersonal skills (e.g. teamwork). Whilst acknowledging the non-technical turn in emergency medicine, I argue that this field needs to extend practitioners' cognition to an ecosystemic activity where cognitive results are shaped by non-local dynamics and situational affordances for actions within the cognitive system. That requires investigations of how task performances are completed as practitioners draw on interactivity. Conventional cognitive and linguistic models are not capable of showing the ecological dynamics of non-technical aspects of task performances. In a similar vein, Hutchins argues:

> In spite of the fact that we engage in cognitive activities every day, our folk and professional models of cognitive performance do not match what appears when cognition in the wild is examined carefully. […] The study of cognition in the wild may reveal a different sort of task world that permits a different conception of what people do with their minds. (Hutchins, 1995a:371)

Before intervention programs, rating schemes, protocols and training courses are developed, healthcare institutions would benefit from perceiving non-technical skills as complex activities that do not allow for absolute separation into distinct areas of competence.

Secondly, an ecological perspective on human interactivity suggests a similar ecological perspective on human errors. Since interactivity is sense-saturated, errors are not simply accidental local achievements. Though individuals *can* be held accountable for bad outcomes, the explanations of what enables individual decisions must be investigated in a broader spatio-temporal frame. By emphasising how error cycles are multi-causal and multi-scalar and how non-local dynamics affect local cognition, the seeds for cultural changes are sowed. Thus, cultural changes require that practitioners change their attitudes towards errors (Moser et al., 2011; Mangels et al., 2006), and their understanding of language and cognition.

Concurrently, an interactivity-based understanding of cognitive coordination does not just allow for a more realistic, naturalised model of language; it also allows for a deeper understanding of how particulars and peculiarities shape cognitive events in complex, real-life situations, such as the emergency ward.

11.3.2 Developing training programmes on the basis of what happens

At the beginning of my work at the emergency department, it developed education and training programmes on the basis of standard procedures and pre-defined hypotheses of where intervention was presumably needed. Such an approach seems to work as doctors and nurses improve and increase their expertise and skills over time. However, it is difficult to show whether such enhancement is due to a general development of experience that happens regardless of the participation in courses or whether it is a direct effect of training. Indeed, there are areas of expertise that obviously need further attention. However in the analyses, I revealed how some task performances were completed in an undesirable fashion, even though such performances were not phenomenologically experienced as error-prone or problematic for task performance (see chapter 6, 8 and 10). For instance in chapter 8.3, the nurse and the doctor jointly and unknowingly re-enact a dysfunctional fixed role-hierarchy that inhibits them in coming up with the best solution. Further in chapter 10, I showed how the documentation process in some cases needs improvement.

Thus, the rapid dynamics of real-time coordination have never been investigated or understood beyond an individual level of subjective experience. Moreover, when a problem has been identified and addressed, new procedures or protocols are often made. Following Flach (1999), human systems are open systems with an unaccounted variability that cannot be controlled by implementing additional standard procedures (Flach, 1999:111). By adding more control into the system, the system becomes less flexible and adaptive and even more control will constrain flexible behaviour, which seems to be crucial in cases of the unexpected (Flach 1999). The answer to practical implications, thus, is not additional control, rules or standard procedures. Rather, it is proposed to prioritise the function of medical *teams*. As shown in the analyses, much is gained from relying on and engaging in the team's sense-making processes in order to develop one's own skills. Thus, coordinated team-performance is crucial in the search for dialogical and functional task performances.

A main challenge is to develop training programs and educational practices that embrace the complexity of human cognition. Due to the biased view that existing models of human decision-making etc. provide, a change in the organisational mind-set is not straightforward. Finally, as education programmes are biased by the idea that the problem is known in advance, the potential for identifying crucial and latent possibilities for error cycles is easily overlooked. As proposed by Hutchins (1995a), and in line with this dissertation's research design, the emergency department is encouraged to work inductively and ask the naïve question: what actually happens, before they provide answers and initiate interventions.

11.3.3 Artefact-rich work environments

Within the medical ward, the number of material artefacts and tools is massive. They are designed with a specific purpose and practitioners are taught these purposes. However, Hollan et al. (2010) underline how they, within the field of aviation and ship navigation:

"have documented many cases of use of structure that were not anticipated by the designers of the tools involved. Experts often make opportunistic use of environmental structure to simplify tasks" (Hollan et al., 2000:182). To them, the big question is how flexibility can be incorporated into the design of such material structures. They argue, that designers should think in terms of *work environments*, rather than the decontextualized function of an artefact (Hollan et al., 2000). As I have shown in the analyses, material artefacts have no intentions. However, their mere physical existence becomes an affordance for certain behavioural actions. As practitioners' level of expertise varies, their visual system allows for different perceptions and actions including how to understand and use an artefact in the situation. Thus:

> work materials are more than mere stimuli for a disembodied cognitive system. Work materials from time to time become elements of the cognitive system itself. Just as a blind person's cane or a cell biologist's microscope is a central part of the way they perceive the world, so well-designed work materials become integrated into the way people think, see, and control activities, part of the distributed system of cognitive control. (Hollan et al., 2000:178)

The reason why some material artefacts occasionally prove dysfunctional in task performance, relates to designers' propensity to confuse invention, conception and cognition (Hollan et al., 2000). Kirsh (2013) emphasises the possibilities of thinking with material artefacts rather than using them purely as a means for speeding up the cognitive process. That we can think *differently* with artefacts is important as it can literally change the way human beings think. Thus Kirsh hypothesises that: "if an object is *cognitively gripped* in the right way then it can be incorporated into our thinking process even if it is not neurally absorbed" (Kirsh, 2013:3:2).

Following Kirsh (2013) and Hollan et al. (2000), educators and designers are not fully aware of the complexity and ambiguity that artefacts can afford in real-life situations. By linking Gibson's ecological theory of visual perception with theories of distributed cognition, understandings of how artefacts afford various possibilities for actions can be illuminated. Such information is valuable for designers, educators and practitioners in the ward. Again, by thinking in terms of *artefact-rich work environments,* the ambiguity of artefact-interaction in diagnostic settings can be embraced.

11.4 The interactivity-based framework and cognitive event analysis

The interactivity-based framework was presented in order to emphasise the underlying assumptions of language and cognition as well as how these concepts are intertwined and relate to multiple timescales. As the dissertation took its starting point in how cognitive events are managed *in situ*, CEA became the main analytical approach to frame such events. As such, starting in the enchronic timescale, CEA was able to work with connections of relevant event pivots rather than a step-by-step temporal analysis of what happens. The organising principle of the analysis is defined by a criterion of cognitive function and as such multiple transition phases and event pivots, which relate to multiple

timescales, are extrapolated from interaction data. However, this dissertation was not just interested in defining local connections of what leads to outcome, but to explain *how* connections are possible in a complex organisation. With CEA we can show what happens and define local constraints and possibilities for problem-solving. However, it does not equip us with a comprehensive basis for answering *why* an incoming phone call prompts practitioners to either ignore or respond to the call.

I argue that the theoretical concepts presented within the interactivity-framework (in particular Hodges and Baron's (1992) ecological account of values, Linell's (2005, 2007, 2009; 2013; 2015) dialogism perspective, Gibson's (1979/86) ecological approach to visual perception, Goodwin's (1994) concept of professional vision, and Streeck's (2010) ecological theory of gesture add explanatory power to why connections in the cognitive event trajectory link up as they do. CEA *in itself* does not explain what makes an enabling condition an enabling condition, but it can point to them as enabling for local cognitive problem-solving. Finally, CEA-investigations of the bio-cognitive dynamical coordination that goes on beyond the enchronic scale of interaction can be enriched with theoretical perspectives on human cognitive, emotional and linguistic capabilities and moral obligations for actions. Thus, CEA's main quality is its ability to link pivots in cognitive systems to relevant situated actions that lead to results, without using a step by step or turn by turn analytic procedure. It studies what real human beings do together and it zooms in on relevant transition phases that are not ordered by a temporal criterion but by one of systemic function. With a focus on systemic function and cognitive results, CEA has its shortcomings if one wishes to add another perspective on interactivity. In chapter 3 interactivity is defined as an 'ontological substrate' (Steffensen, 2013:196), and language and cognition, in turn, are characterised as *perspectives* one can take on interactivity (sense-saturated coordination). However, as CEA focuses on pivots that lead to cognitive results, it adds little to situations where no such results occur in a cognitive system. Steffensen et al., (forth) argue that CEA deals with event pivots that are: "functionally defined as a transition point which is a *conditio sine qua non* for identifying a segment of a cognitive trajectory as a specific (kind of) event" (Steffensen et al, forth.:15). Thus, as the model aims at *specific kinds* of events, it leaves aside non-cognitive events. In this project, I aimed at more than strict cognitive event analysis and I thus combined CEA with other perspectives and theories. I will argue, that some moral aspects of dialogue (Linell, 2009; 2015; Hodges and Baron, 1992), have a positive affect on interpersonal relationship, but they do not necessarily affect the cognitive output in a functional sense. Further, as I showed in the last chapter 10.2, no event pivots were identified as the doctor completed the documentation task without experiencing any 'suspended nexts' (Steffensen et al., forth.). The dysfunctionality of this case was only identified through comparative analysis of event trajectories. Thus, CEA has its shortcomings when problems beyond members' experiences emerge. The way out, I suggest, is comparative analysis and the interactivity-based framework that provides the observer with explanatory powers beyond situated cognitive events.

11.5 Particularities and generalisability

Mainstream psychology insists that for psychological phenomena to be studied systematically, they should be performed in controlled, experimental settings unattached to the social practice where they occur (Dreier, 2007). The decontextualised and impersonal 'pure' results provide knowledge, Dreier claims, that is very different from the knowledge that qualitative studies of psychological phenomena in their ecological settings provide (Dreier, 2007). Likewise, as Hutchins claims: "studying cognition in the wild is difficult, and the outcomes are uncertain" (Hutchins, 1995a:197). However, they are only uncertain, when they are compared to the kind of results that mainstream psychology produces: "qualitative studies need to promote a different conception of generality than the one which dominates psychology" (Dreier, 2007:188). Yet, in this dissertation I qualitatively investigated the naturalistic *wild* by applying analytical models of language and cognition that pivoted on changes in interactivity. With quantitative analyses, one is able to describe general tendencies, but explanatory power of unique coordination in the object under study is unfeasible. For instance, within the domain of human error in emergency medicine, statistical analyses provide insights about the frequency of human error, where it happens and what the consequences are. But as I have shown, the interactions in which the error cycles emerge vary tremendously. In a similar vein, Steffensen (forth.) yields investigations of particulars as ecosystems:

> The ecosystemic emphasis entails that, while the uniqueness of particulars may appear as differences in details, it is not reducible to such details. Rather, one must take the full cognitive or dialogical ecosystem as one's object of study. However, as this system is dynamical, it is irreducible to a static, momentary inventory of finite relata and relations. An ecological system is unique because of its irreducible and irreproducible historical trajectory. Studying cognitive particulars, thus, amounts to studying the unique trajectory of a cognitive system. (Steffensen, forth:4)

In this dissertation, the interactivity-based framework enabled me to study how cognitive events are managed *in situ.* Using the analytical method of CEA, I focused on the rapid temporal dynamics in human interaction. In cognitive coordination, the enabling conditions for solving a specific problem often play out beyond micro-sociological scales of interaction. The main challenge, thus, is to move from particularities to generalisations. This dissertation contributes to the humanities by showing the importance of particulars in medical task performance, not merely by describing these, but crucially by demonstrating *that* particulars matter, *how* particulars matter, and *why* particulars matter. Further, it is argued, that it is only within the humanities that we find methods that pick out why particulars matter. While a theory of cognitive computation or semiotics, for instance, interprets an agent's capabilities for local representation or his local use of static signs respectively, they are incapable of explaining how the articulation of representations and signs emerge in a complex distributed system (Hollan et al., 2000).

The interactivity-based framework proposes such ecological investigation of particular events as bounded and dynamical at the same time. This idea links up with Dreier's insistence that hanging-togetherness should be the locus of interest:

> Insisting on characterising things in isolation is replaced by insisting on characterising the hanging-togetherness of things in social practice. This knowledge leads to insight into the dynamic — contradictory — hanging togetherness of social practice and in social practice (Holzkamp, 1988). Insisting on the concrete hanging togetherness of things does not imply studying everything every time, that is, studying totalities of infinite proportions. It means understanding things by considering them as linked in a pertinent nexus of social practice, that is, the particular hanging togetherness of a particular situation and practice and the relevant hanging togetherness for comprehending the issue of the present study. (Dreier, 2007:3)

Crucial to the ecological perspective on human error, language, and cognition, is the fact that local coordination is understood as sense-saturated. As interactivity is sense-saturated, the slow non-local dynamics are identified in local coordination for instance when a nurse enacts her skills in embodied behaviour coordinated with what the doctor does and anticipates, and with what the physical environment offers. Thus, outcomes are results of a synthesis of non-local dynamics and local possibilities for action. As such the analyses present not just a synchronous and unique picture of situated interaction. They also indicate a historical foundation that constrains local possibilities for action, for instance, when procedures and cultural issues related to role hierarchies and the attitude towards emotions affect local coordination and functional cognition. Finally, the empirical findings presented in this dissertation express multiple dimensions of decision-making, some of them general, and others not. However, this is exactly the crucial point in human flexible adaptive behaviour. To paraphrase Dennett (2013), human beings have competence *with* comprehension; in contrast, ants have competence *without* comprehension. Thus, ants' behaviour is much more generalisable than healthcare professionals'. Healthcare practitioners' behaviour is both bounded and dynamical at the same time. This dissertation reflects this point, for instance when it points out that artefacts are used differently in the ward by different groups of people with different level of skills and expertise. How the artefact is used depends on situated capabilities for action just as non-local, sociocultural patterns and expectations affect the outcome. The dissertation does *not* provide a complete account of the entire ecology of human cognition. Rather, it gives an ecological account of pivotal elements in (dys)functional cognition. The aim was not to provide generalisations of human errors, but rather explain the dynamic and complex condition for error cycles *in general* by providing detailed examples of how they emerge, and how they are avoided. Thus, a cross-section of the ecology was investigated to demonstrate the complexity, spatial extension and multi-temporality of human cognition in complex organisations.

Specifically, when healthcare practitioners engage in dialogue, perform with rich embodiment, rely on the team's sense-making and make decisions based on a value heterarchy, they are more likely to anticipate latent conditions for errors and adapt to these particular changes. This knowledge is valuable in the search for safer, more caring and

dialogical healthcare practices. And as such, this study of particularities is an attempt to bridge the gap between the literature on human errors and the reality in which they emerge. It is my hope, the analyses inform practice in a useful way, and future studies within the field add to this line of research.

11.6 Making an impact: methodological innovations

The dissertation has shown what is gained by applying an ecological approach to human interactivity in the field of emergency medicine. Theoretically, it proposed to work with an interactivity-based framework that allows for investigations of multi-scalar ecosystems. At a methodological level, it showed how one is able to account for non-local dynamics in the local.

This section discusses further how an ecological naturalistic approach opposes classical scientific domains, such as linguistics and cognitive science. Intellectually, linking the humanities and the cognitive sciences, allows for a naturalised view on language, and thus to cutting-edge theories in the language sciences that both enrich the humanities and solve real-life problems. Arguing against cognitive and linguistic compartmentalisation, an ecological approach treats cognition and language as embodied biosocial phenomena that can be investigated in human interaction (Steffensen, 2015; Linell, 2015; Cowley, 2010; 2011; 2014a; 2014b; Steffensen, 2013; Steffensen and Pedersen, 2014; Pedersen and Steffensen, 2014; Pedersen, 2012; Linell, 2009; 2015). As mentioned in chapter 3, the traditional assumptions within language sciences and cognitive sciences were that cognition was an internal representational process, and language was the means for communication and articulation of thoughts. To overcome this dichotomy, the interactivity-based framework enriches the humanities by basing a naturalised theory of language on the study of how language is grounded in human coordination in complex sociocultural settings, or, specifically, how healthcare professionals cognitively and interactionally manage high-pressure work practices in a department of emergency medicine.

At a theoretical level, the interactivity-based framework provides rich explanations of how language is cognitive: "Coordinated sense-making embodies thoughts: we depend on *dynamics first and symbols afterwards*" (Cowley, 2011:11). This dissertation supports this hypothesis. It provides empirical-based analyses of how human beings use language as they rely on real-time coordination to achieve results. As the ecological approach is naturalistic, it grounds language and cognition in inter-bodily coordination. However, the perspective does not reduce human interactivity to an atomic level of coordination, but explains coordination as sense-saturated. That means that biological joint coordination allows biological bodies to become social agents that create joint narratives. In the words of Steffensen: "sociality is our human way of being nature" (Steffensen, 2015:114). The interactivity-based framework, thus, challenges and rejects conventional approaches to language and cognition. It builds on and extends perspectives as distributed cognition (Hutchins, 1995a; Hollan et al, 2000), distributed language (Cowley, 2011; Love, 2004;

2007; Thibault, 2011; 2014; Linell; 2009; 2015) and ecological psychology (Gibson, 1979/86; Hodges and Baron, 1992; Hodges, 2007a; 2007b; Thompson, 2007) that all trace language and cognition to activity. Thus, the interactivity-based framework is rich in theory, but it needs to qualify and adjust methodological approaches that complement each other in the investigations of human ecosystems.

Multiple challenges follow as one opens up for the ecology of human cognition. However, this dissertation does not claim to provide a complete account of human interactivity. Rather it takes the implications of a process ontology seriously and it seeks to investigate real-life settings as ecological, dynamical and complex ecosystems. The analyses thus give an ecological account of decisive elements in functional and dysfunctional decision-making. The process of determining the precise extent of cognitive ecosystems can explain the dynamic and bounded possibilities individuals have for producing cognitive results. This insight connects to the third research question concerning which methodological innovations can be derived from an ecological perspective. Thus, crucial to the ecological perspective on human error, language, and cognition, is the fact that local coordination is understood to be sense-saturated. Activities are shaped by sense-saturated coordination rather than being local instantiations of individual logical choices. Treating human language and cognition as perspectives on interactivity challenges traditional approaches in linguistics and cognitive science to adapt their methods in accord with these foundational assumptions.

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DETAILED CONTENTS

FIGURES

English summary

This dissertation uses an ecological framework to investigate human error in the social practice of emergency medicine. An ecological framework embraces a phenomenon in its wholeness - that means as part of a larger system than that which appears in real-time. The overarching motivation behind this project was nourished by an interest in how the multi-scalarity of human cognition in emergency medicine relates to human errors and successes. Having introduced the field of human errors, the dissertation sets out to answer the overall question:

How do healthcare practitioners manage cognitive events in patient diagnosis and treatment in a way that yields cognitive results?

I further raise three subquestions that relate to the overall research question:

(i) How do healthcare practitioners anticipate and counter errors? How does an emergency medical team function to prevent errors in complex diagnostic situations? How do errors emerge and escalate in a (dys)functional social system?
(ii) How does medical culture affect real-time interaction and how is the culture itself shaped by the exact same dynamics?
(iii) What are the methodological innovations that can be extrapolated from an ecological perspective on human errors and an ecological approach to language and cognition?

The dissertation concludes that an ecological approach is apt for explaining how events on multiple timescales affect cognition in complex organisations. Thus, by tracing practitioners' cognition to an ecosystemic activity, I show how cognitive results are shaped by non-local dynamics and situational affordances for actions within the cognitive system. The dissertation's empirical findings are specific examples of non-local dynamics and situational affordances for action in real-life diagnostic events.

Chapter 2 reviews and contrasts a conversation analytical approach (CA) to social interaction with Hutchins' classic approach to the study of distributed cognition (DC), which are two major approaches to the studies of social interaction. It shows how DC favours embodied information processing within a distributed cognitive system defined by functional properties, while CA underlines the sequential organisation of social orderliness in a local situation. It concludes by claiming that both positions are inadequate in the exploration of the phenomenon in its ecological entirety, as, in each case, the enabling conditions for human behaviour are reduced to a single domain of either social orderliness or representational states.

Building on an ecological view, chapter 3 presents an alternative analytical framework for studying the ecology of human cognition in complex organisations: the interactivity-based framework. This framework provides analytical models and theoretical perspectives

to investigate the multiple time-scales in human cognition. Specifically, the innovative approach of Cognitive Event Analysis (CEA) is used for investigating cognitive events in local interaction.

Chapter 4 presents the project's research design. I use cognitive ethnography to examine the real-time dynamics of medical decision-making and other cognitive events at a Danish Hospital (Køge Hospital). The primary data material consists of video-recordings of 17 real-life diagnostic and treatment situations in the hospital's emergency department. From beginning to end, the case study was carried out by the author - as were the coding and general data processing. Based on the initial coding process, six themes were defined and further investigated.

Six analytical chapters (chapter 5-10) treat these themes as aspects of the diagnostic encounter in the emergency ward. Using the interactivity-based framework, the analyses take their starting point in the enchronic timescale, using CEA to frame cognitive events. From there they move beyond the conversational scale of interactivity and embrace both the rapid pico-scales and the larger cultural scales of interactivity as explanatory resources in the investigation of how cognitive results are reached. The analysis examines how agents, artefacts and expertise are linked on multiple timescales. This analysis seeks to balance (potential) medical error cycles and a more general understanding of how practitioners undertake treatment as a team-based problem-solving activity.

Each chapter, thus, focuses on a thematic aspect related to the systemic function of cognition: (*a*) medical visual systems; (*b*) interruptions; (*c*) diagnostic procedures; (*d*) medical cultural dynamics; (*e*) sense-making in teams and (*f*) writing the electronic medical record. The analyses demonstrate how team members enact expertise-in-action, and also how lack of coordination and communication can lead to human errors. In particular, it shows that non-routine events are crucial to what goes on in the emergency ward: anomalous events afford errors and trigger feedback mechanisms which prompt team members to anticipate possible changes of plans. For instance, it can be demonstrated that interruptions are handled differently depending on the interlocutors' level of expertise, team composition and situational and material circumstances. In conducting empirical analyses of how practitioners manage cognitive events, it becomes evident how the concept of multiple timescales is crucial to understand the enabling conditions of human cognition. Specifically, the chapters show (*a*) how visual systems are extended in space-time, (*b*) how procedures and interruptions constrain practitioners in balancing multiple moral values as part of cognition, (*c*) how cultural patterns shape local role hierarchies that are shaped by the very same dynamics of local interaction, (*d*) how team members co-act and manage cognitive events by relying on the team's sense-making capacities, and finally (*e*) how rich embodiment increases the chances for flexible adaptive behaviour in human-artefact interaction. A common element unites the chapters. Each chapter shows, in different ways, that when practitioners are unable to balance the non-local and local constraints on the system, they fixate on one thing, which increases the risk for the emergence of error cycles. In contrast, when practitioners are capable of balancing non-local and local constraints on the system, they are able to adapt flexibly to changes in the

environment and to anticipate what comes next.

Chapter 11 concludes by summarising how the project's empirical findings respond to the research questions that motivated it. A synthesis of the empirical results forms the basis for a description of their practical implications. These implications are discussed in relation to challenges in everyday medical practice. On these grounds three initiatives are suggested: (*a*) the implementation of a new model of language and cognition in the field, (*b*) changing the basic assumptions of what is relevant content in training programmes and (*c*) dealing with (the design of) material artefacts as flexible *artefact environments*.

The dissertation makes clear that it does *not* provide a complete account of the entire ecology of human cognition. Rather, it gives an ecological account of pivotal elements in (dys)functional cognition. Thus, a cross-section of the ecology is investigated to demonstrate the complexity, spatial extension and multi-temporality of human cognition in complex organisations. The process of determining the precise extent of cognitive ecosystems can explain the dynamic and bounded possibilities individuals have for producing cognitive results. This insight connects to the third research subquestion, the one concerning which methodological innovations can be derived from an ecological perspective. Crucial to the ecological perspective on human errors, interaction and cognition, is the fact that local coordination is understood to be sense-saturated. Behaviour is shaped by sense-saturated coordination rather than being local instantiations of individual logical choices. In this, the interactivity-based framework contrasts with other approaches to human interaction, and for the reasons mentioned above it provides the best option if the aim is to study dynamics in the ecology of human life, including human cognition.

Finally, a broad, long-term ambition of this project is to contribute to an ecological turn within the humanities and the cognitive sciences. By showing the results of embedding naturalistic studies of human interactivity in an ecological framework, the project illuminates the benefits of treating language and cognition as ecological, distributed and intertwined in interactivity. In so doing, it challenges traditional approaches in linguistics and cognitive science to adapt their methods in accord with these foundational assumptions.

Dansk resumé

Med afsæt i en økologisk ramme undersøger denne afhandling menneskelige fejl i den akutmedicinske sociale praksis. En økologisk ramme favner et fænomen i dets helhed – det vil sige som en del af et system, der er større, end det fremstår i realtid. Den gennemgående motivation bag projekter er vakt af en interesse for, hvordan multi-skalaritet i menneskelig kognition i akut medicin relaterer til menneskelige fejl og succesfulde hændelser. Efter at have introduceret feltet inden for menneskelige fejl, besvarer afhandlingen det overordnede undersøgelsesspørgsmål:

Hvordan forvalter sundhedspraktikere kognitive events i diagnosticerings- og behandlingsprocesser af patienter på en måde, der frembringer kognitive resultater?

Jeg rejser desuden tre underspørgsmål, der relaterer til det overordnede undersøgelsesspørgsmål:

(i) Hvordan foregriber og håndterer sundhedspraktikere menneskelige fejl? Hvordan fungerer et akutmedicinsk team i forebyggelsen af fejl i komplekse diagnostiske situationer? Hvordan opstår og hvordan eskalerer fejl i et (dysfunktionelt) socialt system?

(ii) Hvordan påvirker en medicinsk kultur lokal interaktion, og hvordan er en sådan kultur formet af de selvsamme dynamikker, der udgør lokal interaktion?

(iii) Hvilke metodologiske udviklingsmuligheder kan der udledes på baggrund af et økologisk perspektiv på menneskelige fejl og en økologisk tilgang til sprog og kognition?

Afhandlingen konkluderer, at en økologisk tilgang er velegnet til at forklare, hvordan multi-temporale events påvirker kognition i komplekse organisationer. Ved at koble praktikeres kognition til en økosystemisk aktivitet viser jeg, hvordan kognitive resultater er formet af ikke-lokale dynamikker og situerede potentialer for handling i et kognitivt system. Afhandlingens empiriske resultater er specifikke eksempler på ikke-lokale dynamikker og situerede potentialer for handling i autentiske diagnostiske situationer.

Kapitel 2 evaluerer og kontrasterer en konversationsanalytisk tilgang til social interaktion (CA) med Hutchins' klassiske tilgang til studiet af distribueret kognition (DC), som er to dominerende tilgange til studiet af social interaktion. Kapitlet viser, hvordan DC prioriterer kropsligt forankrede informationsprocesser i et distribueret kognitivt system, der er defineret ud fra funktionelle egenskaber, mens CA understreger den sekventielle organisering af social orden i en lokal situation. Kapitlet konkluderer afslutningsvist, at begge positioner er utilstrækkelige i undersøgelsen af et fænomen i dets økologiske helhed – i begge tilfælde er betingelserne for menneskelig adfærd reduceret til et enkelt domæne af enten social orden eller repræsentationelle tilstande.

Med afsæt i et økologisk perspektiv præsenterer kapitel 3 en alternativ analytisk ramme til studiet af menneskelig kognition i komplekse organisationer: en interaktivitetsbaseret ramme. Rammen fremsætter analytiske modeller og teoretiske perspektiver til undersøgelsen af multiple tidsskalaer i menneskelig kognition. Særligt den innovative *Cognitive Event Analysis* (CEA) anvendes til undersøgelsen af kognitive events i lokale interaktioner.

Kapitel 4 opstiller projektets undersøgelsesdesign. Jeg anvender kognitiv etnografi til at undersøge autentiske situerede dynamikker i beslutningsprocesser og andre kognitive events på et dansk hospital (Køge Hospital). Det primære datamateriale består af 17 videooptagelser af autentiske diagnostiske situationer på hospitalets akutafdeling. Fra start til slut er casestudiet udarbejdet af undertegnede, dette gælder også kodningsprocesser og databehandling. Ud fra den indledende kodningsproces blev seks temaer opstillet og undersøgt yderligere.

Seks analytiske kapitler (kapitel 5-10) behandler de opstillede temaer som aspekter i den diagnostiske proces på akutafdelingen. Med afsæt i interaktivitetsrammen tager analyserne deres udgangspunkt på den såkaldte enkroniske tidsskala med udgangspunkt i CEA til afgræsningen af kognitive events. Derfra bevæger analyserne sig udover den konversationelle skala og behandler både hurtige pico-skalaer of langsommere kulturelle skalaer som eksplanatoriske ressourcer i undersøgelsen af, hvordan kognitive resultater opnås. Analysen undersøger, hvordan agentive individer, artefakter og ekspertise er sammenkoblede på flere tidsskalaer. Analysen forsøger at balancere (potentielle) medicinske fejl-cyklusser og en mere generel forståelse af, hvordan praktikere udfører behandling som en teambaseret problemløsningsorienteret aktivitet.

Hvert kapitel fokuserer på tematisk aspekt relateret til den systemiske kognitive funktion: (*a*) medicinske visuelle systemer; (*b*) afbrydelser; (*c*) diagnostiske procedurer; (*d*) medicinske kulturelle dynamikker; (*e*) betydningsskabelse i teams og (*f*) færdiggørelse af den elektroniske medicinske rapport. Analysen demonstrerer, hvordan teammedlemmer frembringer ekspertise *in-action,* og også hvordan manglende koordination og kommunikation kan medføre menneskelige fejl. Den viser i særdeleshed, at events, der ikke kører på rutinen, er afgørende for, hvad der sker på akutafdelingen: afvigende events virker som betingelser for fejl og udløser feedback-mekanismer, der tvinger teammedlemmer til at foregribe mulige ændringer i handleplaner. Fx vises det, hvordan afbrydelser håndteres forskelligt afhængigt af de involveredes ekspertiseniveau, teamkonstellationen samt situationelle og materielle forhold. Ved at gennemføre empiriske analyser af, hvordan teammedlemmer håndterer kognitive events bliver det tydeligt, hvordan begrebet multiple tidsskalaer er altafgørende for at forstå mulighedsbetingelserne for menneskelig kognition. Helt specifikt viser kaptitlerne (*a*) hvordan visueller systemer udvides i tid og rum, (*b*) hvordan procedurer og afbrydelser begrænser praktikernes mulighed for at balancere flere moralske værdier i beslutningsprocesser, (*c*) hvordan kulturelle mønstre skaber rollehierarkier som på samme tid skabes af de selvsamme dynamikker i den lokale interaktion, (*d*) hvordan teammedlemmer samhandler og håndterer kognitive events ved at bero på teamets betydningsskabelsespotentialer og sidst (*e*)

hvordan omfattende artikulation af kropsdynamikker øger muligheden for fleksibel adaptiv adfærd i menneske-artefakt interaktion. Et fælles element forener kapitlerne. Hvert kapitel viser på hver sin måde, at praktikere fikserer på ét element, når de er ude af stand til at balancere ikke-lokale og lokale begrænsninger i systemet. Modsat er praktikerne i stand til at tilpasse sig fleksibelt til forandringer i omverdenen og foregribe det næste skridt, når de formår at balancere ikke-lokale og lokale begrænsninger i systemet.

Kapitel 11 opsummerer, hvordan projektets empiriske resultater svarer på undersøgelsesspørgsmålet, som indledningsvist motiverede det. En syntese af de empiriske resultater skaber fundamentet for en beskrivelse af deres praktiske implikationer. Disse implikationer diskuteres i relation til udfordringer i den medicinske hverdagspraksis. På den baggrund opstilles tre tiltag: (*a*) implementering af en ny forståelse af sprog og kognition inden for feltet, (*b*) en ændring af de grundlæggende antagelser af, hvad der er relevant indhold i trænings- og uddannelsesprogrammer og (*c*) at behandle og forstå (design af) materielle artefakter som fleksible *artefaktmiljøer.*

Afhandlingen understreger, at den *ikke* giver et fuldstændigt billede af hele den menneskelige kognitions økologi. Derimod giver den en økologisk beskrivelse af afgørende elementer i (dys)funktionel kognition. Et tværsnit af denne økologi undersøges altså for at demonstrere kompleksiteten, den spatielle udvidelse og multi-temporaliteten i menneskelig kognition i komplekse organisationer. Processen med at bestemme det præcise omfang af kognitive økosystemer kan forklare de dynamiske og bundne muligheder individer har for at producere kognitive resultater. Denne indsigt relaterer til det tredje af de tre underspørgsmål, det der vedrører, hvilke metodologiske udviklingspotentialer, der kan udledes af et økologisk perspektiv. Vitalt for det økologiske perspektiv på menneskelige fejl, interaktion of kognition er det faktum, at lokal interaktion forstås som meningsmættet. Adfærd er formet af meningsmættet koordination og er dermed ikke tilfælde af lokale individuelle valg. Sammenfattet kontrasterer interaktivitetsrammen andre tilgange til menneskelig interaktion og på baggrund af ovenstående grunde tilbyder denne ramme den bedste tilgang, hvis formålet er at undersøge dynamikker i den menneskelige økologi inklusiv menneskelig kognition.

Sidst opstilles en omfattende og fremtidsrettet ambition i dette projekt, nemlig at bidrage til en økologisk retning i human- og kognitionsvidenskaberne. Ved at vise resultater af situerede naturalistiske studier af menneskelig interaktivitet inden for en økologisk ramme belyser projektet fordelene ved at behandle sprog og kognition som økologisk, distribueret og sammenbundet med interaktivitet. Dermed udfordrer projektet traditionelle tilgange inden for lingvistikken og kognitionsvidenskaben til at tilpasse deres metoder i overensstemmelse med disse fundamentale antagelser.

Appendix A: Review: Conversation Analysis AND healthcare

#	Author	Audio/video	Multimodal analysis	Focus and findings: Verbal analysis
1	Aiarzaguena et al, 2013	Video	No	Doctors struggle with symptom explanations due to the complexity of describing complex biological processes. This is seen in degree of hesitation, self-interruption, repetitions and silences
2	Ariss, 2009	Video	No	Moral dimensions of epistemic authority constrain doctor and patient's conversational resources
3	Beck, 2012	Video	The doctor aligns with the patient's communicative project through body movement	Patient search for moments where the interaction is closing down to introduce additional concerns
4	Bergen and Stivers, 2013	Video	No	Half of all disclosures are patient-initiated
5	Britten et al, 2004	Audio	No	Doctors respond to patients' expression of aversion in two ways: eliciting the patient's view directly or disengaging and refusing to discuss the patients' views
6	Buus, 2006	Audio	No	Linguistic and social conventions were identified in handovers: the handovers were characterised as non-interactional or interactional with each distinctive interaction pattern
7	Campion and Langdon, 2004	Video	Analysis shows how both turns-at-talk and shift in gaze indicate shifts in topics	
8	Chatwin, 2008	Audio	No	How micro-analysis of interaction unveil features of behaviour that are hidden when other methods are applied
9	Chatwin, J, 2006	Audio/Video	No	Doctors attenuate patient narratives in subtle ways and patients can display 'self-censorship' in narrative construction
10	Cohen et al, 2011	Audio	No	When doctors identify patient concerns in interaction and links such concerns with relevant health behaviour, a

				teachable moments occur which can lead to behavioural changes of the patient
11	Collins, 2005	Video	No	Distinctive features of nurses' and doctors' explanations relate to their formal roles
12	Gafaranga and Britten, 2003	Audio	No	The nature of a consultation is locally negotiated by the participants, hence first concern elicitors and selection rules are not externally decided a priori, but established in situ
13	Gill et al, 2010	Video	No	In practices of pre-emptive resistance, patients first give explanations for their symptoms and then report circumstances that undermine these explanations
14	Gill, 2005	Video	*Non-verbal tasks (as writing, reading in papers etc.) affect the flow of interaction*	Interaction analysis unveils how the patient uses an inquiry about availability of diagnostic tests in a way that suggest her interest in obtaining it and how the doctor avoids to respond explicitly to this implicit request
15	Greatbatch et al, 1995	Video	No	Computer technology directly impacts practitioners' conduct and disclosure of information about their patients
16	Greenhalgh et al, 2013	Audio	No	Opportunities for discussions of quality of life are either closed down or opened up in interaction
17	Heritage and Robinson, 2006	Video	No	A typology of questions used by physicians to solicit patients' problems were developed
18	Ijäs-Kallio et al, 2011	Video	No	The use of minimal responses, and positive and negative extended responses approve, appraise or challenge doctors' decisions
19	Jones, 2007	Audio	No	Patients were never told that an assessment was underway. The topical flow of interaction indicated a pre-structured assessment form that did not take individual patients' perspectives in mind
20	Joosten et al, 1999	Video	No	Psychosocial explanations are jointly evaluated and accomplished in doctor-patient interaction through mutual effort
21	Karhila et al, 2003	Video	*Few times, the value of eye*	Negotiation is controlled by nurses, who actively present relevant problems and

			contact and smiles are added to analysis	proposals to the patients
22	Kettunen et al, 2002	Video	No "The emphasis of this study was to examine verbal communication" p.103	Power is jointly co-constructed. Patients have options to construct power and flow of interaction with questions, interruptions and extensive disclosure
23	Kettunen et al, 2001	Video	No	Different participation frames that produce taciturnity were identified in verbal interaction
24	Koenig, 2011	Video	*Accepts are sometimes given with head nods and other embodied actions serve as precursors to verbal announcements*	Patient negotiate and co-construct what counts as acceptable treatment recommendations, e.g. by resistance and non-acceptance
25	Lehtinen, 2013	Video	No	Doctor responses and their hedging devices fit form and function of patient's presentation of personal experience
26	Lehtinen and Kääriäinen, 2005	Video	No	Doctors use linguistic resources to respond to patients' information from other sources which is discrepant with information given by the doctor
27	Li and Arber, 2006	Audio	No	Nurses construct patients' moral identities and how they use emotion talk when interpreting patients' behaviour
28	Lutfey, 2004	Video	No	Patient compliance is a medical label which sense become constructed in realtime interaction
29	Mallett and A'Hern, 1996	Video	No	A case shows how use of humour reveal information about patient's anxiety
30	Mallett, 1990	Video	Nurses use both verbal utterances and body movements to engage the patient in interaction	
31	McCormick et al, 2006	Audio	No	Three themes were identified and problematised in alcohol-related discussions: patients disclosed

				information, vague advice and discomfort
32	Monzoni et al, 2011	Both video and audio data	No	Patient resistance as overtly expressed through disagreements, challenges, rejections or passively through silence or minimal responses
33	Newman et al, 2010	Video	The pauses are related to *activities* as reading in papers, using computers etc.	Large-scale analysis of presence of pauses and their regularities are made. Small pauses are preferred for resuming on the same topic. Longer pauses are treated as a period for resuming the conversation
34	Nishizaka, 2014	Video	When pregnant woman have difficulties in differentiating an image on the screen, the practitioner employs actions that require bodily movements to structure the images on the screen	Uses illustrations
35	Nishizaka, 2013	Video	Changes in visual orientations are embodied movements of head and eyes, and they are often the most crucial resources for sequential organisation of interaction	Uses illustrations
36	Nishizaka, 2011	Video	No	Shows how pregnant woman expand their responses to practitioners' routine questions to take initiative in problem presenting
37	Nishizaka, 2010	Video	Non-verbal resources are crucial for the formation of pregnant woman's	Uses illustrations

			recognisable problem presentations	
38	Park, 2013	Video	When last-minute concerns are raised in three out of 60 cases the doctor redirect his gaze toward the computer and maintain the closing	Uses illustrations
39	Park, 2009	Video	Non-verbal actions influence participants' production speech and silence	Interactions in Korean primary care are monotopically organised
40	Pillet-Shore, 2006	Video	During non-verbal documentation processes, the client sees the opportunity to deliver extensive information	Clients deliver information beyond what is required in accomplishment of weighing activity in order to demonstrate that they posses knowledge regarding weight or to proffer interactional opportunity for affiliation
41	Pilnick and Zayts, 2014	Video	No	Uncertainty is interactionally managed for instance by the use of hedging when results are bad or by describing results as estimations
42	Pilnick and Zayts, 2012	Video	No	Clients' socioeconomic circumstances are managed and impact on decision-making. The doctor often controls the interaction flow as he e.g. declines to answer or withhold information until tests are taken
43	Pilnick and Coleman, 2003	Video	No	When smoking is linked to a patient's current medical problems, patients show resistance in an explicit way
44	Poskiparta et al, 1998	Video	Reflective conversation used a flexible structure with various question types combining	

			embedded, check-up, alternative and feeling questions. The types also reflect the non-verbal communication, e.g. laid back attitude, gaze etc.	
45	Rees and Monrouxe, 2008	Audio	No	The use and function of pronouns and pronoun shifts in interaction affect how doctors and patients conceptualise themselves
46	Rhodes et al, 2008	Video	How gaze and body orientation between computer and patient influence style, pace, content and structure of the interaction	Uses drawings
47	Rhodes et al, 2006	Video	Gaining eye contact is a way of showing interest in the answer	A structured checklist supresses patients' agendas and encourage nurses and doctors to adopt a narrow-task-based approach to the consultations
48	Robinson, 2009	Video	No	Patients' low levels of participation is related to an interactional structure of social action
49	Robinson and Heritage, 2005	Video	No	Physicians and patients mutually orient to presentations of here-and-now experienced symptoms
50	Robinson, 2001	Video	No	Different communication strategies to negotiate the closure of the encounters were identified
51	Rodriguez et al, 2011	Audio	No	The length of the relationship between doctor and patient with advanced cancer is related to the duration of communication about health-related quality of life
52	Rogers and Todd, 2000	Audio	No	Oncologists control the agenda and focus only narrowly on pain (e.g. through questions in closed form) which is perceived to be outside their specialist remit

53	Rossen et al, 2014	Audio	No	Clarification is treated as good news as it confirms absence of serious illness or results in a diagnosis that leads to relevant treatment offers
54	Ruusuvuori and Lindfors, 2009	Video	No	Complaint sequences are designed as discreet, embedded in presentation of problems as well as facilitating without requiring affiliation. Complaints do not emerge as explicit adjacency pairs but as co-constructions of negative stance
55	Ruusuvuori, 2007	Video	No	Different types of affiliative turns are identified. Participants orient to affiliation as working to towards closing a sequence of troubled talk and to shift back toproblem-solving
56	Toerien et al, 2013	Audio	No	Two verbal strategies for initiating treatment decision-making are used: recommending and option -listing
57	Von Friederichs-Fitzwater and Gilgun, 2001	Video	No	Doctors and patients use predominantly transitory symmetrical exchanges in interaction
58	Webb, 2009	Video	No	The timing and lexical choice of doctors' opening question deliveries such as 'how are you' function to enable the patient to give information. Patients tend to report either successes or lack of success in making weight loss progress
59	Wynn, 2005	Audio	No	Describing types of empathy in sequences of doctor-patient interaction and how such sequences of empathy matter to the participants
60	Zayts and Kang, 2010	Video	No	Information delivery is jointly co-constructed and doctors can tailor the information by using initial inquiries as a means of introducing new information

Appendix B: Review: Distributed Cognition AND healthcare

#	Author	Methodology	Focus of unit of analysis	Findings
1	Bang and Timpka (2007)	Ethnographic study	Human-artefact	In emergency situations the staff organises paper-based records spatially on a desk in order to create a base for shared communication within a team. The organisation enabled efficient communication overview, ranking of patients' medical status, etc. resulting in cognitive offload
2	Bossen and Jensen (2014)	Ethnographic study	Human-artefact human-human	When physicians achieve overview, they rely heavily on material artefacts, and especially the electronic patient record (EPR). This insight has implications for future design of EPR
3	Collins et al. (2010)	Ethnographic study	Human-artefact	Clinicians preferred verbal communication in information exchanges over electronic documentation as the electronic system was perceived as 'a shift behind'. However, developing electronic documentation tools that capture real-time information may lead to a more efficient practice
4	Fioartou et al. (2010)	Based on previous results	Human-human	Distributed situation awareness helps avoiding fixation errors. By investigating the emergent properties of a system rather than individual behaviour, attention is to how information is distributed within a team and across artefacts rather than on their existence alone
5	Furniss et al. (2011)	Ethnographic study	Human - artefact	The design of interactive medical devices should be developed on the basis of observational studies of how they fit the specific context in which it should be used
6	Gorman et al. (2003)	Ethnographic study	Human-artefact	Order emerges from interaction with various healthcare people and by employing technology and information sources in the interaction process.

7	Grundgeiger et al. (2014)	Ethnographic study	Human-artefact	Distributed prospective memory operates on a systems approach to unveil what happens in the interaction between the individual and environment
8	Grundgeiger et al. (2009)	[34]		Nurses' prospective memory is supported by properties of the environment and such insight informs device design and healthcare education
9	Hazlehurst et al. (2007)	Cognitive ethnography	human-artefact	Six distinct communication patterns between surgeons and cardiologists were identified. Each pattern was related to functional properties of the activity system
10	Hazlehurst et al. (2003)	Cognitive ethnography	human-artefact	Systems that deal with information resources must be designed in a way that allow for complexity
11	Hazlehurst et al. (2003)	Cognitive ethnography	Human-artefact	Distributed planning in surgery is characterised by pre-defined cognitive and physical resources in a bounded activity system
12	Kaufman et al. (2009)	Cognitive ethnography	Human-artefact	Telemedicine is a complex intervention with many possible workflow interruptions due to technical issues. The level of adaptability among staff members are crucial to the success of telemedicine
13	Lin et al (2014)	Cognitive ethnography	Human-artefact	Themes as e.g. hierarchical power, ineffective communication and competing priorities were identified in patient discharge processes. Evaluation of tools and strategies to improve situational awareness are important steps towards safer practices
14	Masci et al. (2012)	Based on previous results	Human-artefact	A distributed cognition perspective is embedded in a tool-based method to incident investigations
15	Masci and Curzon	Based on previous	Human-artefact	A DC model contributes additional knowledge – that was hidden to other

[34] The study was conducted in an ICU of a large tertiary hospital. Each ICU patient bay is equipped with a computer and an electronic patient information system including an hourly observation form and a work-list that presents medication orders and nursing tasks in a temporal order. A patient is cared for by a single bedside nurse, and up to six bed side nurses are supported by a bay nurse.

	(2011)	results		methods - about issues that led to a well-known incident
16	Mylopoulos and Farhat (2014)	Cognitive ethnography	Human-human	Purposeful improvements are socially distributed as well as over time and materials
17	Nemeth et al. (2006)	Cognitive ethnography	Human-artefact	The use of cognitive artefacts unveils insight that goes beyond the operator. These results can be used to design computer-based that aid cognition
18	Nemeth et al. (2005)	Ethnographic study	Human-artefact	By studying the use of cognitive artefacts, deep structures of individual and a team's distributed cognition is identified and can be the basis for developing computer-supported artefacts
19	Nemeth et al. (2004)	Cognitive ethnography	Human-artefact	It is shown why computer-supported cognitive artefacts must be advanced in order to make teamwork processes more resilient
20	Pelayo et al. (2009)	Ethnographic study	Human-human	Organisational features impact coordination and communication procedures in medication preparation processes by nurses
21	Rajkomar and Blandford (2012)	Ethnographic study	Human-artefact	Significant distribution of cognition was identified in an intensive care unit: socially among nurses, physically via the material environment and technological artefacts
22	Rajkomar and Blandford (2012)	Ethnography	Human-artefact	By observing interruption resumption that involves artifacts from a DC perspective, opportunities for improving artefact design were identified.
23	Rajkomar and Blandford (2011)	Ethnographic study	Human-artefact	Shows how DC is a valuable when studying the collaborative nature of healthcare work. For instance when nurses coordinate, when artefacts play a coordinating role for action etc.
24	Sarcevic et al. (2008)	Ethnographic study	Human-artefact	Team transactive memory is important and inefficient communication processes hinder the function of such collective memory. Technological solutions are mentioned as opportunities for reducing cognitive effort needed in

				the working memory of trauma teams
25	Sarcevic et al. (2012)	Ethnographic study	Human-artefact	Four types of trauma team errors were identified: communication errors, vigilance errors, interpretation errors and management errors. Key information structures to support team cognition and decision making were developed
26	Tariq et al. (2013)	Ethnographic study	Human-artefact	Gaps in three systemic dimensions are identified: 1) design of cognitive artefacts, 2) inter-organisational coordination mechanisms and 3) communication bandwidth. Furthermore, it identifies how awareness of such gaps enhance the understanding of medication errors in RACFs
27	Weibel et al. (2013)	Cognitive ethnography	Human-artefact	Electronic medical records (EMR) interaction both facilitates medical decision-making and constrains doctor-patient communication. This insight should inform design of new multimodal healthcare interfaces
28	Wilson et al. (2007)	Ethnographic study	Human-artefact	In situ evaluation of cognitive artefacts is important as things that could not be expected to happen happens as an artefacts is in use.