Insights and their emergence in everyday practices

The interplay between problems and solutions in emergency medicine

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The aim of this article is twofold. First, it is a theoretical and empirically based contribution to the branch of research that studies enabling conditions of human sense-making. It demonstrates the value of a coherent ecological framework, based on dialogism and interactivity for the study of sense-making, problem-solving and task performance in naturalistic contexts. Second, it presents a promising method for the analysis of cognitive activities, *Cognitive Event Analysis* (CEA), with which we investigate real-life medical interactions, especially the emergence of insights in procedural task performance in emergency medicine. We show *how* sense-making and insights are accomplished by medical teams when they integrate cultural expertise, professional skills, inter-bodily dynamics, material constraints and affordances within the environment, i.e. when local co-action is embedded in socio-cultural patterns of behaviour.

Keywords: human sense-making, insight, problem-solving, problem-finding, interactivity, cognitive event analysis, emergency medicine, ecological cognition

1. Introduction – Towards an ecological framework of interactivity and sense-making in emergency medicine

In various professions, for example in healthcare, practitioners need to make decisions, solve problems, anticipate what comes next, coordinate with team members, etc. In this article we will examine the emergence of insights and the interplay between problems and solutions in emergency medicine teams. Obviously, such teams make decisions about diagnoses and possible treatments of patients, but we will not focus on the making of these vital decisions, but rather on how solutions

to various nested practical and professional tasks or problems emerge in the course of the everyday practices on the ward.

Our analysis will allow us to draw some important theoretical and methodological conclusions. At the theoretical level, we will join those researchers (e.g. Klein 2015) who have claimed that decision-making and problem-solving in naturalistic contexts do not fit a model according to which participants set up a number of possible options for solutions before the decisive cognitive events and then choose from among these options. Instead, participants observe what happens in the course of their continuous practical work and communicative interaction, exploiting this for making perceptual discriminations, using their experiences of established routines, i.e. their "cultural ecosystems" (Hutchins 2014), and making these locally relevant. In this way, they recognise patterns and occasionally arrive at partly new insights, sometimes by serendipity, which will eventually make sense to them as solutions to problems. The problems are not necessarily present in their minds beforehand, but are realised when 'solutions' appear as insights: they find problems to observed solutions.

The analyst's identifications of the micro-details of participants' arriving at insights in their ongoing work processes presuppose access to suitable methods for analysing rapid and only partly verbalised events. We have chosen *Cognitive Event Analysis* (CEA, see Section 3.2), which we apply here to naturalistic task performances that can be viewed as problem-analysis in real life, rather than – as has frequently been done – for analysing problem-solving in experimentally designed tasks. We will argue that CEA, which is what one might call a detailed "pico-analysis" (Thibault 2011, Cowley & Nash 2013), is an important and more potent alternative to the usual methods of analysing naturalistic micro-interaction in, for example, *Conversation Analysis* (Schegloff 2007).

2.   Some theoretical preliminaries

2.1   Problems and solutions in an ecological perspective

On the ward, medical teams solve problems all the time. Some problems are highly complex and unique, whereas others seem to be recurring and easy, as the solutions emerge naturally because expertise is enacted almost automatically in the situation. We will suggest that managing cognitive events (whether complex or easy) successfully depends on the individuals' capabilities for coordinating and integrating situated real-time demands with cultural routines, rules, conceptualisations and power relations. In terms of theory, such cultural conditions can be understood as situation-transcending (Linell 2009), distributed (Hutchins 1995), and ecological

(Gibson 1979, Hodges 2009, Steffensen 2013, Jensen 2014, Pedersen 2015). Such processes are characterised by a complex interplay between local and non-local enabling conditions.

The underlying assumptions of an ecological approach to problem-solving are hardly compatible with the classical models of cognitive practices. A recent review (Elstein & Schwarz 2002) of the cognitive literature on clinical problem-solving and diagnostic decision-making reaches the overall conclusion that within this context reasoning should be described as a process of hypothesis-testing. In experimental settings, this comes about through artificial set-ups with a 'game-like' function. The game-like function comes about in the experimental design based on tricking the participants into cognitive traps when they try to move forward and solve the task, i.e. when they try out moves to win the game. Hence, the participants are sometimes even misguided or misled into a constructed problematic situation (Vallée-Tourangeau 2013, Cowley 2014, Steffensen, Vallée-Tourangeau & Vallée-Tourangeau 2016) that may enhance frustration and make them search for a bedrock in the core aspects of 'pure' reasoning. The logic seems to be that when they come across an *impasse*, individuals will retreat to reasoning logically and systematically. While this approach may generate important insights into a limited domain of constructed problems, it is not obvious that the dynamics and the results will be applicable to broader contexts of natural task performances in which problem-solving is nested.

Ecological problem-solving contexts are constituted by heterogeneous sets of dynamics and logics. As we demonstrate in the analysis, problem-solving is less about pure mental reasoning than about trusting each other, working together, and picking up information in a rich and dynamic environment. Furthermore, problems are rarely isolated and subject to binary choices, as they appear to be in many experimental settings. In real life, they are rather messy, unclear and nested in a broader context of multiple actions. Consequently, this classical scientific approach to problem-solving has been adopted by organisations and it has led to a practice whereby attention is paid to individuals and their personal, mental thinking processes, their verbal accounts, and how they follow written instructions or share information, etc. (Reason 2005, 2008, Pedersen 2015). Such mentalistic approaches assume that problems can or must be known before solutions. For example, it is often believed that problem-solving consists of an investigation of solutions found by medical hypothesis-generation used to guide the data collection and to develop a diagnostic plan. Elstein and Schwarz (2002) point to the problematic aspects of dealing with real-life cognitive problem-solving in such a simplistic way. According to them, the hypothetico-deductive approach does not really apply to situations in which experts engage in familiar situations, as "their speed, efficiency, and accuracy suggest that they may not even use the same reasoning processes as novices"

(Elstein & Schwarz 2002: 730). Thus, different types of methods are applied in different reasoning contexts based on the observation of physicians' flexible approach to problem-solving. In the view of Elstein and Schwarz, easy problems are solved by pattern recognition, whereas complex problems require a more thorough and systematic reflection, based on hypothesis generation and testing.

In this article, we will argue that an ecological alternative to that of Elstein and Schwarz (2002) is needed if the aim is to account for the variety of problem-solving activities that appear in real life. Recent cognitive ethnographic research shows that many problems are not solved by individuals. Many problems are not isolated processes, but instead constitute an interconnected problem heterarchy, and they are often unspecified and emerge ad hoc. And yet again, many problems are not solved by logical deduction as they relate to e.g. emotional dynamics in the interaction (Pedersen 2015, Klein 2015, Jensen & Pedersen 2016). The alternative provided here derives from cognitive anthropology, in particular as developed by Edwin Hutchins and presented in his seminal book *Cognition in the Wild* (1995). In line with an ecological perspective, he describes cognitive processes as distributed, messy and emergent. In an ecological perspective, problem-solving should not be viewed as an example of how an individual or a team deals with an easy or hard problem based on hypothesis-testing, pattern-matching or categorisation. Rather, it is recommended that the focus be on results emerging from a cognitive system (Hutchins 1995, 2014, Pedersen 2015, Steffensen, Vallée-Tourangeau & Vallée-Tourangeau 2016). The emergence of results often reveals a pathway that is inconsistent with a fixed structure of problem identification, reasoning, and action. In writing this article, the authors have been influenced by two different, but related, ecological approaches, namely, the *interactivity perspective* (IP) (Steffensen 2013, 2015) and *extended dialogism* (ED) (Linell 2015, 2017).

A few words about ED first. While the core of classical dialogism (Bakhtin 1981) has been centred on individuals' selves and their interdependencies with others as sustained primarily through verbal interactions, ED is not exclusively fixed on social communication, but deals with sense-making (cognition, perception, and niche-construction) in inter-bodily interaction in general, and also with sensory perception (Linell 2017). This means that cognition and interaction are enabled by the constitution of our minded bodies and embodied minds. Gallagher (2011) argues that embodiment and interaction are necessarily interlocked in human sense-making. Together with other communicative resources, our senses can be used to create a categorisation, a differentiation and an enrichment of the world to be perceived and apprehended by us.

IP also places emphasis on the fact that human action is always sense-saturated (Steffensen 2013), and that coordination is constrained by a historical social and biological being. It does not work with a fixed centre of action (single

individuals or brains, for instance), instead it scrutinises ecological niches or organism-environment systems (Järvilehto 1998, 2009). In both IP and ED, human achievements are neither enabled by processes located in a disembodied mental realm, nor located in a purely situated bodily interaction.[1]

2.2   Sense-making and double dialogicality

Before proceeding to our subject matter, we would like to end this section by briefly commenting on our use of the terms *sense-making* and *double dialogicality*. As we will see, these two concepts are related; the latter can be understood as the means for the former.

What is meant by *sense-making*? Dialogism, i.e. theories of dialogue and dialogicality (Linell 2009, 2017), highlight communication as involving sense-making of selves, others, and environments, including the affordances of objects and artefacts. The somewhat vague term *sense-making* is then used in a comprehensive sense that includes both various forms of direct (some say not semiotically mediated) processes of e.g. sensory perception, and the more conscious *meaning-making*, which is semiotically mediated, often through language (speech or text). Sense-making occurs in different sorts of activities: communicative activities, 'mental' activities (e.g. thinking and imagination), and also practical activities (learning and practising skills in doing practical things, such as cooking a meal).

Sense-making concerns understandings, i.e. the bringing of order to one's world. While this is often carried out in external dialogue, it also builds on constant interaction with material environments as well as more abstract contexts. While ordinary (sensory) perception of our physical surroundings regularly builds upon an interplay between (individuals') perceptual-exploratory (motor) actions and the sensory impressions from the affordances of the environment (cf. Noë 2004),[2] it is also true that sensory perception is indirectly related to earlier experiences of interaction with others. Seniors have guided the novice's perceptions and told him or her how objects, properties and processes could be discerned and linguistically

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1.   A historical explanation of the differences between ED and IP might be that ED was born in the tradition of dialogism (dialogue studies) and language studies (Garfinkel 1963, Bakhtin 1981, Vygotsky 1986), whereas IP is an outcome of cross-disciplinary interactions with cognitive science (Hutchins 1995, Kirsh 1997, 2013, Hollan, Hutchins & Kirsh 2000) and ecological psychology (Gibson 1979, Noë 2004, 2010, Hodges 2009, Chemero 2011).

2.   Note that we do not focus on *sense-making* within organisations of the kind that Weick (1995) is concerned with (such as organisations promoting self-images by producing narratives about the organisations' histories, purposes, etc.).

categorised. Sense-making is, as we will soon see, related to the emergence of insights too. This is at the heart of ED.

What is meant by *double dialogicality?* When people communicate in situated interaction, they make sense at several levels. Minimally, we can discern two levels (Linell 2009, 2017). First, there is the direct interaction between the participants who are present, and in particular, **present to each other** 'there and then'. This is the primary and most concrete aspect of interpersonal communication. But participants also orient to more remote parties (real persons who are not present), and generalised (and perhaps imaginary) others whose (real or imagined) norms participants relate to. These are peripheral others (also called "third parties" (Linell 2009)) and may be regarded as representing non-local voices. (Recall the introduction with regard to what the non-local conditions of emergency medicine teams might be.) While the non-local conditions are "situation-transcending" (Linell 2009), we want to stress that participants orient to both present and absent others by (aspects of) the very same communicative activities, i.e. those which take place in situ. These may therefore be seen as (at least) doubly dialogical. Let us provide a few examples. Consider participants' attitudes to norms that may define the social situation (or activity) type at hand. Usually, participants take the activity type (e.g. a dinner party, a football match, or a wedding ceremony (Levinson 1992)) for granted, and simply conform to its implicit norms. This may have some communicative effect, for example, that parties do not want to deviate from expectations. However, sometimes participants may choose to deviate from norms, e.g. dress codes, in order to produce specific communicative effects. For example, *Femen* is an international activist group of young female feminists, one of whose campaign methods is to appear bare-breasted in public. This may express a kind of ridiculing of social norms, which recipients have to respond to, for example, by remaining indifferent or by dissociating themselves. Bakhtin (1968) dealt with the carnivalesque as a kind of deviant and extra reality.

Less radical deviations from norms may include odd language varieties. By choosing a certain social dialect or style, a person can express accommodation or distancing. This may be due to conscious stance-taking or pure ignorance. In our study we will extend the use of *double dialogicality* to yet more 'normal' behaviours. It will be evident in our data that participants in emergency care communicate directly with each other and with the specifics of their present cases. These are local conditions. But participants must also rely on experiences from their biographies as professionals and as human beings. These are "non-local conditions", parts of their cultural ecosystems (Hutchins 2014), which to some extent are made relevant in their present practices. These may include aspects of participants' experiences of the use of technology, categorisations of patients' medical (and other) conditions, kinds of measures taken in emergency care, the meaning potentials of words, linguistic

actions and bodily gestures in both professional jargon and practice and in every-day life, and also memories of particular exemplar utterances and interactions in participants' professional biographies, etc.

In other words, non-local conditions relate to habits and norms that participants have appropriated earlier in life. Note again that non-local conditions will only have a functional effect if they are actualised at some level in the situated encounter; they have to be 'made relevant' locally, there and then. With regard to *double dialogicality*, we are faced with **both** voices of participants' previous norms, habits and experiences, **and** the voices of self and others here and now in the actual encounter. We will especially point to cases in which participants gain some insights by treating the present situation in ways that are partly different from similar cases before. This illustrates the creative use of non-local experiences as applied to novel cases.

3.   Data and methods

This section presents the data corpus and the selected data set for this particular paper. Finally, it frames the choice of methods discussing the ramifications of using CEA for the analysis of this kind of data.

3.1   Data

The following analysis is based on real-life video-data drawn from a study on human interactivity in emergency medicine. It uses cognitive video-ethnography to investigate how coordination is maintained over time and is shaped by the rapid dynamics of local interaction (see Pedersen 2015). Specifically, the study was conducted on an emergency ward at a Danish hospital where medical teams diagnose patients with various acute symptoms. The project used participant observation to observe the material culture systematically and intensively over a two-month period. After this two-month period, it introduced video-observation, including interview gathering over a one-month period. The study comprises 17 diagnostic treatment situations from a period of one month, which were video-recorded with up to three cameras. The recorded situations involved various kind of medical emergency situations spanning cardiac arrest, appendicitis, severe chest pains, etc. The length of each recording varied significantly and lasted between 30 minutes and several hours depending on the flow in the ward, the patient's medical symptoms, etc.

In this paper, we have selected two cases where medical teams engage in medical diagnostic practices during which instances of insights emerge in different

ways. The motivation for choosing the two instances was nourished by an interest in understanding the cognitive dynamics enabling the emergence of insights: how one comes to see new aspects of an activity. Relevant questions in this regard are: how do participants engage with each other and their environment, and how do they enact situation-transcendent experiences when new observations are made?

The first case involves a doctor who struggles to identify the cause of a patient's low pulse. In the analysis, we home in on how insight emerges as the doctor exploits the resources of the materiality and physicality of the environment and links narratives to local and previous observations. The second example involves anticipatory problem-solving as a result of ad hoc team constellations. As a medical team coordinates the medical procedural performance of a FIC-blockade (see Section 4.2), the nurse suddenly observes how the doctor deviates from standard procedures on the ward. The nurse gains a new understanding of how procedures **can** be managed functionally and with less resources than usual on the ward.

While the first case demonstrates, say, a rather classical example of distributed problem-solving in relation to spatial and material distribution of cognitive processes, the second case further emphasises the importance of working in different teams. By discovering links across time and between different medical team constellations, states of which practitioners are not aware become useful for future diagnostic processes on the ward. Thus, the two cases of insight emergence are chosen to underline the importance of studying naturalistic processes of how the link between non-local and local interaction leads to new understandings of previous, current *and* future situations.

3.2   Cognitive Event Analysis

We aim at investigations of how professional healthcare practitioners make sense in the wild, i.e. how they manage pre-treatment and other activities embedded in the overall task of diagnosing patients on an emergency ward. While the goals are clear in this context, much is unspecified and the setting (just as sense-making) is often characterised as messy, complex and saturated with uncertainty and, at times, confusion. Sometimes practitioners become biased and fixate on the wrong aspects in interaction, at other times they just do what they do, or they reflect upon procedural actions and make sense of them in important ways that can lead to changed performances and procedures. *Cognitive Event Analysis* (CEA) allows for investigation of changes in the *cognitive trajectory* that lead to results or fixation, which is of crucial importance in the field of organisational task performance.

As we have proposed, ecological approaches investigate what happens as a result of the interplay between situated interaction and phenomena grounded in previous

events and ideas about what the future might bring along. CEA transcends local and situated processes. This will make it crucially different from various methods (and theories) that dominate both micro-sociological approaches such as *Conversation Analysis* (CA) and mainstream cognitive science. While CA deals with limited, local turn-by-turn exchanges of (mostly) verbal articulations as relevant units of analysis (Sacks, Schegloff & Jefferson 1974), (mainstream) cognitive science deals with local interactions between input and behaviour or intra-cranial interactions in an alleged mental realm. By contrast, with CEA, and its general backgrounds IP and ED, morality, emotions, desires, needs, cultural norms, organisational demands and values, individual or social habits, local affordances, serendipities and even chance all have an impact on the shaping or making of the interactivity trajectories we investigate. Obviously, the comprehensive interplay of all these factors cannot be studied in one single analytic project. But CEA has drawn the bow fairly far.

CEA emerged from a need to grasp human interactivity and sense-making as ecological and multiscalar. Its theoretical roots are thus grounded in the ecological and dialogical framework described above (Cowley 2014, Steffensen & Pedersen 2014, Pedersen & Steffensen 2014, Trasmundi 2016). This means that sense-making is investigated as coordination between agent(s) and an environment extended in time and space. CEA is an ecological method that investigates how distributed cognitive systems (Hutchins 1995, Hollan, Hutchins & Kirsh 2000, Giere 2004) achieve results as they rely on real-time dynamics and non-local conditions for coordination (Steffensen 2013, Cowley 2014, Steffensen, Vallée-Tourangeau & Vallée-Tourangeau 2016, Trasmundi 2016). A distributed cognitive system includes all components that contribute to cognitive processes and results, including people (self and others), material artefacts, environmental structures, cultural conditions, and routines, etc. (Hutchins 1995). Results are the achievements of human actions that enable the individuals to manipulate the ecological setting in accordance with a particular goal.

The methodological procedure of CEA consists of methodological steps based on video-recordings (Steffensen 2013, Steffensen, Vallée-Tourangeau & Vallée-Tourangeau 2016). The first step is to define the event that is being investigated; e.g. a *problem-solving event* with a learning potential. The event may be defined from an observer's or a participant's point of view. Analytically, CEA takes its starting point in the interactional timescale on which local coordination of flexible, adaptive behaviour is played out. The second analytical step concerns defining relevant *event pivots*, which are moments in which something significant happens in the interactivity trajectory towards results or outcomes. An event pivot indicates the point where changes in the trajectory emerge, which further signifies the location of a phase transition; for instance, when a team is having a breakthrough or a decision is made, which changes the orientation and the dynamics in the system noticeably.

CEA works with connections of event pivots (which are parts of an overall retrospective evaluation of the whole event (here the emergence of insight)) rather than a local and causal, step-by-step, temporal analysis of what happens. Such nested events or local actions may happen by serendipity, by automatised and routinised actions or on purpose, and they generate a new layout of affordances (Chemero 2000, 2003) from which upcoming solutions can be discerned and evaluated.

CEA combines the member's perspective with a scientific perspective, which allows for the exploration of questions as to **how** individuals make sense in the wild. For instance, as practitioners do their job and spend time with other practitioners, they use observations that lead to insight in order to change their perceptions of their histories. In our study, the data and the questions we raise afford a method that analyses the micro-ecology of professional sense-making in emergency medicine.

The approach invites the analyst to deal with multiple timescales. However, the method itself pays particular attention to the rapid dynamics of coordination that involve e.g. bodily dynamics played out at a level below a micro-sociological timescale. According to CEA, no timescale taken in isolation gives a comprehensive understanding of the human condition for action. Instead, it becomes possible to understand human action as multiscalar and dialogical. The ways CEA operates in actual analyses will now be exemplified by closely studying two excerpts from our corpus.

4. Analyses

In the social practice of emergency medicine, many emerging situations are difficult to categorise as problem-solving, decision-making, memorising, or insight emergence, etc., since these events and activities often overlap. While an event might be characterised as either A or B, it is rarely experienced as such in situ by the performing individuals. This is not due to individuals being unaware of what they are doing, but results from the fact that many events simply do not follow the predefined structure outlined in typologies of cognitive abilities and skills.

Our case study involves two episodes that involve the emergence of insight in medical interaction. We define insight in the simplest way, i.e. as a process whereby a participant suddenly sees a solution clearly in the problem-based context: the so-called *Aha!* experience (Bowden et al. 2005). In this analysis, we emphasise (a) situations where insight emerges as a result of exploiting material resources of the interaction in ways that generate enabling conditions for rich action possibilities, and (b) situations that illustrate the creative link between non-local experiences and local observations. Such sense-making situations can be investigated as being doubly dialogical.

4.1   Case 1 – Think-aloud strategies: Verbal utterances as material anchors

This first case relates to how an insight is achieved by relying on the richness of the materiality of the environment. It is an example of how best practice involves activities that are not accounted for in protocols and guidelines. Further, it 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 in which an experienced doctor listens to a 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 the time, but as the doctor uses a think-aloud approach, he suddenly realises what might be causing 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, with its local materiality increasing the ability for cognitive manipulation. Utterances are activities, and activities change the world. To support this hypothesis, we draw primarily on Hutchins' (2005) idea of *material anchors*. Hutchins defines this 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). We refer to thinking aloud as a strategy for creating material anchor points that facilitate complex cognitive problem-solving.[3]

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 & Maglio 1994: 513). 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, we show how a thinking-aloud strategy serves as a cognitive resource for sense-making rather than as a socio-dialogical action as the doctor

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3.   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 our 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.

suddenly links a problem with a solution. Yet, one may assume that thinking *aloud* gives other team members a chance to understand what is going on in another's mind. The situation as a whole pivots on the cognitive benefit from thinking aloud when cognitive challenges emerge. As we enter this interaction, the doctor is being reminded about the unsolved problem as the equipment warns the team about the critical medical values.

Excerpt 1.

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1. 06:29:80, ps. (7.6) (D examines P with the stethoscope and the
                      surveillance monitor beeps)
2. 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
3. 06:43:30, ps. (0.4)
4. 06:43:70, D:   so that is presumably the reason why
5. 06:44:70, ps. (1.8) (D listens to P's lungs)
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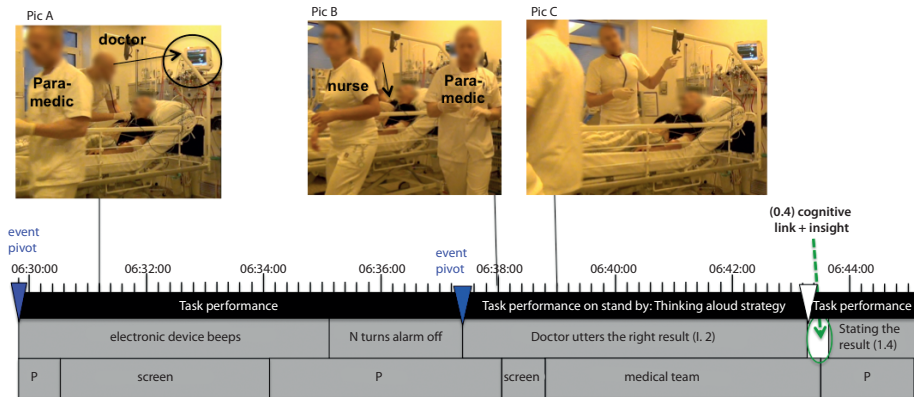

Figure 1. Thinking aloud as a cognitive strategy
The last layer in this event trajectory scheme indicates the doctor's gaze direction

Figure 1 visualises how the doctor balances task performance (patient examination) with emergent information about the patient's unclear condition (the values appearing on the screen). As he engages in task performance he combines procedure following with a thinking-aloud strategy that affords new perceptions with consequences for how a locally 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 1, picture A). The beeping serves as an event pivot and it guides the doctor's attention towards 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 the continuation of what he is doing (see Figure 1, picture B). However, with a delay he does orient to the previous beeping – the event pivot that is crucial for the changes in the interactivity trajectory – and 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 2). 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 for several seconds (see Figure 1, picture C). Cognitively, he interrupts his own examination task and he shifts from listening to the lungs to explicating a hypothesis before he resumes the examination. As he finalises his utterances he resumes the examining task.

If we scrutinise the doctor's utterances further, they seem to indicate a cognitive aspect of dealing with a medical puzzle. His utterance in line 2 is different from his utterances beyond this sequence in many ways. It lacks coherence and clarity, as his sentences are non-grammatical and contain self-interruptions. Initially, the doctor's utterance, which was in fact punctuated with internal pauses, 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 the form of an explanation. The segment *(xxx) treatment* is followed up by an elaboration topicalising the side effects of the treatment. In this case, one side effect appears to contribute to understanding the problem, that of the low pulse rate. Yet the doctor seems unaware that he has solved the problem, and he resumes the examination task. However, by framing the problem verbally, he provides public (though evanescent) 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 seconds pause is a sign of a realisation phase in which the doctor experiences his observation as an insight, which is expressed immediately afterwards: *so that is presumably the reason why* (Figure 1, line 4). As such, the problem is solved during his utterance in line 2, but it is perceived as a result or solution only afterwards. Cowley (2014) has shown this reverse, or non-linear, 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 2014: 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 who are occupied

with other tasks. Nonetheless, he chooses an alternative to silent reasoning: the thinking-aloud strategy. His verbal articulation is the final event pivot that makes him both develop an argument and realise it as a solution. 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 become manifest in a perceivable order. 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 per-
> formance […] 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 his own expertise and the qualities of verbal articulation. He comes to understand the patient's situation in a new light as he creatively animates the material resources for thinking in the local interaction. The example shows how speaking (aloud) and cognition are part of the same activity in complex cognitive reasoning. While his expertise affords him with the opportunity to work calmly and professionally on multiple tasks simultaneously, sense-making emerges as he exploits multiple conditions for problem-solving locally: speaking out loud, focusing on information (the screen), and linking perceived symptoms to information about the patient's history, as Figure 1 visualises. Finally, the problem emerges locally as the beeping reminds him of important medical problems, which is different from the second case below.

4.2   Case 2 – The emergence of insight: Linking local perceptions with experience

In this case, we are interested in how a nurse is able to identify and link a solution in the here-and-now to a non-present challenge or alleged problem on the ward by using her experience as a particular way of picking up relevant information.

While insights are identified as local changes in interactivity trajectories, they often impact the individual's non-local memories of previous situations, too. Observing a solution enables you to identify the nature of previous situations in a new perspective as being flawed or problematic, for instance. In our next example, we underline how such an insight emerges as a nurse observes and makes sense of a successful procedural performance and relates this information to performances in the past. The insight enables a problem analysis, which, in this context, enables her to problematise standard procedures on the ward. Generally, such standard procedures have been characterised by tacit ignorance, and are being problematised in the situated interaction due to the emergence of local insights. While the insight relates to local and non-local operations of professional procedural performance, it further enables anticipatory problem-solving, as the nurse is able to take precautions against problematic task performances in the future.

In our second example, the medical team consists of an experienced nurse and a novice doctor who had worked on the ward for only a couple of days when the recordings took place. The medical team has just decided which procedures should be initiated: the performance of a femoral nerve block (*FIC-block*). This specific standard procedure becomes the basis for learning. After the patient has been informed about the pre-treatment process and the procedure has been explained to her, a 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 can insert the needle. And third, the doctor must perform the FIC-block itself. Under normal circumstances, the third step is impeded by the fact that the marking (first procedural step) is made by pen and the ink often disappears when it is cleaned with alcohol (second procedural step). In standard situations, a consequence of this challenge would be that the doctor needs to allot a lot of cognitive effort to memorise exactly where the mark was in the first place when the third procedural step is to be executed. Figure 2 is an overview of the setting.

Figure 2. Overview of the layout

4.2.1   *Defining the event and its phases: Reverse problem-solving and learning*
Within the overall situation of preparing and performing the FIC-block, there are
nested events. One of those events is an emergent problem-solving activity, which
is a result of serendipity, as performing the FIC-block offers perceptual affordances
to the experienced nurse that can lead to safer and more efficient work practices
in the future. Following CEA, we categorise this event as a *learning event*, as the
observation of the task performance leads to an insight that allows information to
be incorporated into existing procedures in new ways.

Excerpt (2) contains the English translation of the verbal interaction of the
relevant episode. As we enter the interaction, 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. In other words, we enter the conversation *in medias res*,
as the focus is narrowed down to the learning event that can be identified when
the nurse perceives an unfamiliar procedure and she expresses an interest in the
alternative method that the novice doctor uses.

Excerpt 2.
```
1.   43:52:00, N:    did you make such a mark in the skin
2.   43:54:10, ps.   (0.5)
3.   43:54:50, D:    ye:s can you see that
4.   43:55:50, N:    yes (.) how did you make it
[…] (25.5) [The patient complains 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[ff
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
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The analysis will identify four phases: (1) cognitive puzzlement, (2) explanation,
(3) observation as insight, and (4) contextualisation of learning. The analysis is
thus structured into these four phases that will be investigated in relation to one
another. The phases reflect different dynamics and functions that all lead up to an
understanding of how each phase contributes to the cognitive insight, which is later

perceived as such. With CEA, the focus is on how phase transitions are enabled, and on the enabling conditions for the transitions categorised as event pivots (Steffensen 2013: 201), i.e. as conditions pivotal for the event's emerging route. Thus from a CEA point of view the event pivots are identified as important events in the trajectory that lead to noticeable changes. The event pivots and their connected phase transitions are visualised in Figure 3.
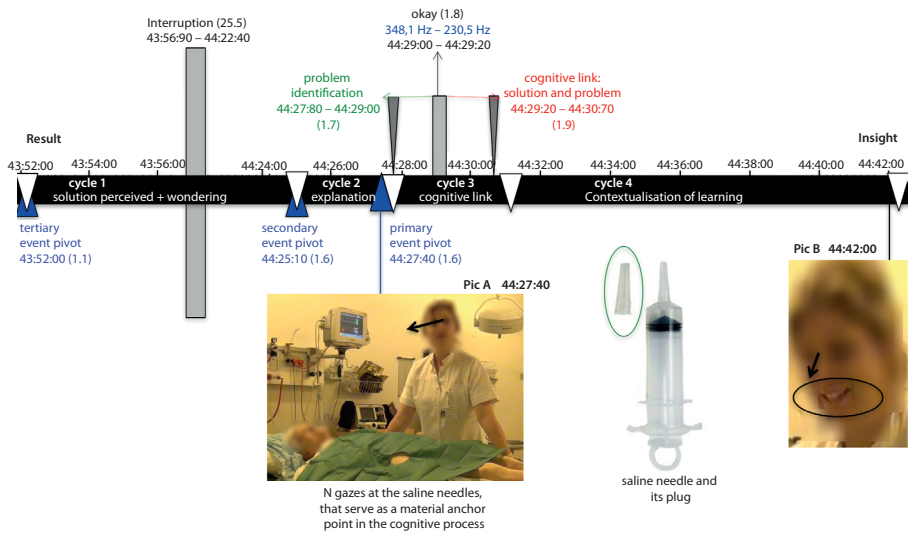
Figure 3.   The interactivity trajectory visualises how local observations are linked to phase transitions and the generation of insight

As mentioned before, the needle insertion site is usually marked with ink that disappears as it is cleaned with alcohol right after. However, this novice doctor marks the insertion site with the plug from a saline needle (see Figure 3), which leaves a temporary depression in the patient's skin. This action deviates from how expert doctors on the ward perform the procedure. While the novice doctor has only worked on the ward for two days, she has learnt the procedure elsewhere and brings a new perspective to this ward. Alternatively, she simply chooses what seems obvious, as she has not yet learnt the ward's routinised work procedure. Within the overall interaction, something noticeable happens when the nurse perceives this procedure: the interaction dynamics change. The marking serves as an event pivot as it indicates a break from the original procedural work-flow to a phase saturated with cognitive puzzlement (see Figure 3). The event's beginning is thus identified in the nurse's question in line 1 – during which the doctor marks the patient's skin with the plug – because it is at this point that the doctor's performance triggers the nurse's interest, which leads to surprise and a conversation about medical

procedures and general work procedures. In this first phase, cognitive puzzlement (lines 1–5), we observe the nurse's sense-making as a mere concern about the operation of the marking (how it is done) rather than non-local awareness (that this marking procedure is better than marking with ink that disappears). Until now the dynamics reveal puzzlement and an interest in getting more information. Intrigued by the mark's appearance, the nurse asks how the doctor has accomplished marking the skin in this particular way (lines 1 and 5).[4] Such an exchange is not standard practice on the ward: first, from a medical perspective, the procedural steps are of no relevance for the nurse, since only doctors perform these procedures. Second, time constraints often inhibit practitioners in conversational debates during diagnosis or treatment activities, and third, the perfectionist culture often prevents practitioners from exposing their inexperience, especially when the patient is listening. Accordingly, the nurse's question indicates a deviation from standard practice in many ways. Here, it develops as a clinical detour where the cognitive system is able to recalibrate its function flexibly throughout the interaction.

4.2.2   Explanation and procedural observation as insight: The materiality of thinking and professional vision

The second and the third phase, the two intermediate phases, are explained as a logical transition prompted by the nurse's question in line 1. But as we will show below, they reveal unexpected results. The second phase is constituted around the doctor's answer (line 6). However, the most salient aspect is not merely that the doctor replies to the nurse's question (as one would expect from a micro-sociological perspective), but more the answer's embeddedness in the material-medical environment. The doctor's wordings and the integration of the material environment into the interaction add value to the nurse's cognitive sense-making. The doctor points and gazes toward the saline needles as she verbally answers the nurse's question: *I took a eh a plug from e:h those saline needles* (line 6). This material embeddedness of the answer affects the trajectory and the thinking of the nurse. Therefore we will show in detail what affords this initial interest and a sudden change in the trajectory that leads to a phase transition.

As the doctor utters *those saline needles*, she guides the nurse's visual attention to the actual location of the saline needles because she gazes and points in their direction. This utterance, accompanied by the doctor's gazing and pointing, is marked as the event pivot that changes the phase of questioning into a phase of

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4. The nurse receives no answer to her question in line 1, 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.

explanation (see Figure 3). As the nurse perceives the answer (line 6), it changes her subsequent strategy for exploring the affordances constituted by the doctor's procedure. The nurse has listened and is turning the information into a coherent hypothesis or explanation. She hears and sees that the mark is made with the help of saline needles available on the ward, but this explanation is insufficient to the nurse: she continues transforming the affordances into meaningful interpretation of medical performance in a way that, once again, changes the interactivity trajectory considerably. Silence and fixation become the functional criterion for defining a new phase in the event. The third phase transition is identified as *observation as insight*, because the nurse now sees the marking procedure as something more than just a marking procedure. It emerges in the moment the nurse gazes at the needle in the middle of line 6, when the doctor is in the process of explaining and pointing. The visual discovery of the needles thus serves as a crucial event pivot. As the nurse visually perceives the needles, the doctor has finished her explanation; the nurse fixates her gaze and she freezes for a moment (see picture A in Figure 3). Again, the materiality of the needles plays an important role in the nurse's cognitive sense-making. A lapse of 1.2 seconds (line 7) emerges as she gazes at the needles. This is the only time in the event trajectory that the nurse is not in motion, which indicates that she starts connecting the local interactional dynamics (emotions, perceptions, sounds, objects, wordings) to non-local cognitive memories, i.e. situation-transcending sense-making. In other words, the actual materiality of the saline needles becomes closely coupled with the nurse, as the cognitive system reconfigures the nurse's cognitive processes. They serve as a material anchor point (Hutchins 2005) for reflection, and 1.2 seconds later she bursts out into *okay* (line 8). Another lapse of 1.5 seconds follows (line 9) before she concludes: *that was pretty clever* (line 10). During those 2.9 seconds, **something** suddenly made sense to the nurse, and to sum up: multiple dynamics in the cognitive event trajectory indicate that she links the anchors (the needles, the wordings, etc.) to the creative procedure (the marking) and further on to the procedural challenge to the department's practice in general (the disappearing ink). It is relevant to treat the nurse's perception of the mark and the needle as phenomena with rich information beyond their physical contours. She sees the mark as something more than a mark, something with value to her professional agency.

Gibson contrasts his ecological approach to visual perception to those communicated in general textbooks and handbooks (Gibson 1979: 1), which ground their explanations of perception in physiological models of the retinal image.[5] He defines

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5. "Direct perception is what one gets from seeing Niagara Falls, say, as distinguished from seeing a picture of it. The latter kind of perception is *mediated*. So when I assert that perception of the environment is direct, I mean that it is not mediated by the *retinal* pictures, *neural* pictures,

them as shallow because they separate sensations from knowledge: "our reasons for supposing that seeing something is quite unlike knowing something come from the old doctrine that seeing is having temporary sensations one after another at the passing moment of present time, whereas knowing is having permanent concepts stored in memory" (Gibson 1979: 258). Gibson's alternative, his theory of information pickup closes the gap between perception and knowledge, as individuals become aware of the world by living in it: by feeling, tasting, seeing, smelling it, etc. His approach to visual perception corresponds with our ecological take on insight and problem-solving activity. This notion of perception as an extension of knowing applies to the nurse's action.

We will now zoom in on how knowing relates to sense-making or perception. Within the same context, multiple actions contribute to learning. The insight is enabled by multiple local and non-local conditions. The non-local concerns the nurse's understanding of general practice and work procedures, whereas the local conditions relate to the doctor's explanation, her pointing and gazing at the needles (the solution). With CEA, those conditions are marked as event pivots that lead to the insight and consequently to the learning result which can be used to improve practice. However, other studies have emphasised the function of shifting gaze during insight problem-solving (Lichtfield & Ball 2011). For instance, they have shown how cueing individuals' attention towards relevant visuospatial components increases the likelihood of task success (Lichtfield & Ball 2011). Similarly, in this case, we observe a result of cognitive work embodied in the nurse's tone of voice supported by her fixated gaze during the first lapse (line 7) when the doctor has pointed in the direction of the needles, cueing the nurse's attention towards the solution. While the nurse identifies the information just perceived as relevant, she starts wondering, thinking, hesitating, and then comes up with a worthwhile connection. In phase one, the nurse only observes or notices the acts of the doctor, but as she links her prior observations with more perceptual cues, she makes direct sense of the information picked up in ways that lead to insights. In other words, the nurse has identified the marking as a solution to a challenge or a problem. However, it is a non-local problem in the sense that it is not grounded in the local context of interaction. Her thinking is *situation-transcendent* (Linell 2009) or *sense-saturated* (Steffensen 2013), which means that she understands her environment in terms of her history as a professional; a process which she only later reflects on (phase four). Finally, it is relevant to state that the nurse is only able to make sense of the environment in the way she does due to her level of expertise, as it provides her with

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or *mental* pictures. *Direct perception* is the activity of getting information from the ambient array of light. I call this a process of *information pickup* that involves the exploratory activity of looking around, getting around, and looking at things." (Gibson 1979: 147 [italics in original])

a *professional vision* (Goodwin 1994, 2000). Goodwin has written extensively about this notion, for example, in the work of archaeologists, who learn to see details and nuances in dirt that are invisible to the untrained eye. When iterative actions and interactions sculpt categorical patterns and shapes over time, they provide the interlocutors with a professional vision, 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). The nurse's experience and professionalism enable her to see the marking and the saline needles as resources beyond the local situation, namely, for general medical practice. The moment she realises that the mark and the needles are solutions to general procedures, she becomes engaged in embodied cognitive work. This engagement is reflected in her fixation behaviour (Figure 3), her conversational pattern, as well as her vocal pitch. We performed a measurement of the pitch patterns, and a clear change was noticeable: the nurse's *okay* in line 8 stands out. This utterance is visualised in Figure 4.

okay
348.1 Hz–230.5 Hz

500 Hz

348.1 Hz

75 Hz

0.070019   0.173486
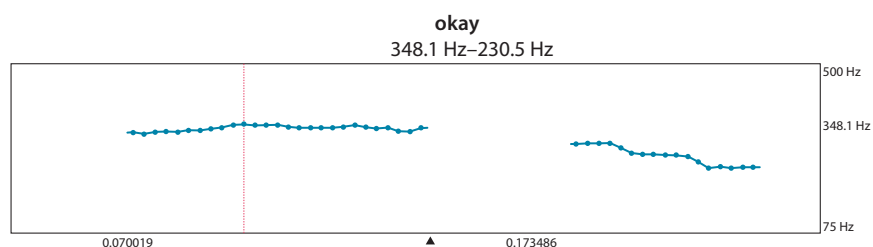
Figure 4. Maximal pitch of *okay*: 348.1 Hz. Pitch range for *okay* in line 8: 118 Hz

First of all, a lapse followed by a delayed response (acknowledgment or evaluation) is a noticeable event since nothing else requires her attention at that exact moment; she is visibly not attending to any other work procedure or perceptual affordances. Further, at no other point in this conversation does the nurse's vocal pitch get close to this level. Her average pitch during the whole event is around 250 Hz and the second highest pitch point is in line 4 at the end of the question where it reaches 300 Hz. Her *okay* thus marks a shift in interactivity, and it is placed between two lapses (1.2 seconds and 1.5 seconds in line 7 and line 9) that surround the 0.2 seconds of the utterance. Before the first lapse, she did not explicitly reflect on the general applicable function this procedural approach could have, and after the second lapse she provides a rather explicit expression of praise (line 10). Later, she relates the doctor's method to a more general procedural level beyond the local situation: *I have actually also (.) often thought about that* (line 19). The lapses and the noticeable change in pitch underscore a deviation from her pitch baseline. Thus, the example shows how thinking is embodied and doubly dialogical, and that interaction

theories are alternatives to the individualist *Theory of Mind* (which holds that one's mind is largely hidden away from others) (Gallagher & Hutto 2008).

In early CA literature (e.g. Heritage 1984) the acknowledgement *okay* and the assessment *that was clever* have been described as *change-of-state tokens* (Heritage 1984), which are – in a sense – indications of new insights (however minimal). They can also be interpreted as a way of assisting the doctor in maintaining face by acknowledging the new information the nurse has received. But the interaction also provides the nurse with a richer understanding. Consequently, the nurse – as an individual – has learnt something. While the doctor provides the solution, the nurse makes the cognitive link between a local solution and a general challenge on the ward. The *okay* is more than a verbal stance marker that accounts for new information. The vocal pitch deviates noticeably from the pitch baseline in the global trajectory in this sequence. The pitch change and gaze fixation is part and parcel of the physiological and sociological dimensions of sense-making processes. They do not just indicate or point to changes in perception or cognitive activity; they are cognitive actions in themselves. 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 organism-environment interactivity or the distributed cognitive system. The link between local embodied experience and abstract and general situations takes time and requires a cognitive effort. Thus, taking the two isolated lapses, the gaze pattern, and the rapid timescales of pitch as evidence, it is shown how cognitive insights are facilitated in a team beyond micro-sociological collaboration and individual mental processing.

4.2.3   *Contextualisation of learning*

Only a few moments after the nurse has issued her *okay*, we perceive the results of the cognitive process as she links the local situation to the general practice on the ward (lines 10, 13 and 19). This final part of the interaction constitutes the fourth phase of the event: the contextualisation of learning (see Figure 3). The nurse makes explicit that the 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). The *that* at the end of line 19 refers to the problem. In this specific context, she puts together her new, locally achieved knowledge (the insight) with the non-local *that* in a way that is recognised as *problem identification*, and as she utters *that*, she smiles in a noticeable way that she has not done before during the overall conversation (see Picture B in Figure 3). Actually, her actions can be characterised as both problem identification and learning (Figure 3). The nurse's behaviour and the cognitive results that emerge add to our understanding of the enabling conditions for insights in interactivity. The nurse benefits from the cognitive system. She does not herself come up with the solution. Rather, she ('dialogically')

uses the doctor's actions and products of action (the marking), her verbal utter-ances (explanations), and the material environment (the saline needles) as means to solution-finding, problem-identification and anticipatory problem-solving (they anticipate a solution to a long-standing challenge). Thus, the cognitive result is an outcome of trustful co-action between nurse, doctor and the environment, with the doctor as a main agent but the nurse as the main cogniser.

This case is interesting as the marking challenge or the problem is in a sense absent, or at the least backgrounded. The problem is not in front of the nurse and the doctor, it is a problem that exists beyond this activity: in the past and potentially in the future. The nested cognitive results that emerge in situ might lead to anticipatory problem-solving in similar future situations. Further, only the nurse knows the character of this procedural hurdle, which in the light of the new procedure can be phrased as a problem, and although the doctor has had the solu-tion at least for some time, she has not known that it is a solution to a problem. Further, this situation-transcendent activity reflects the dialogicality of cognition; the nurse's sense-making is best explained beyond a representational level of per-ception. However, what she observes is related to her own experience on the ward, which is why the nurse and the doctor do not see the same. In line with the theory of direct perception, the nurse sees it as something valuable in relation to general work procedures, whereas the doctor sees it as a natural procedure that is not in need of any explanation. In other words, the situation-transcendent nature of cognition is what allows the nurse to define and anticipate a procedural challenge, which is non-existing for the doctor. The problem is not to be seen or solved, but to be deduced (found) during information pickup (Gibson 1979) based on material anchors, experience and aided by a professional vision (Goodwin 1994).

5.   Concluding discussion: Thinking out of the problem box

In this paper our perspective has been one of evaluating insights, learning and problem-solving in emergency healthcare, which sometimes involve longer, non-local timescales. Nonetheless, we have used a method, CEA, which is apt for analysing local micro-activities organised around cognitive tasks in detail. It iden-tifies relevant events and actions that lead to results in terms of both problem identification (making prior problems more explicit and precise) and solutions to these problems. While CA is focused on micro-analysis of natural-language interaction,[6] CEA might be termed "pico-analytic" (Thibault 2011, Cowley & Nash 2013). If we understand the emergency medicine team's coordination as cognitive

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6.   It should be noted that CA also includes some experimental approaches (Kendrick 2017), but these attempts are still rare.

behaviour, with a focus on how successful tasks are performed, enhanced and understood in the team, CEA is apt for investigating such coordination. The medical event is an external categorisation defined around a pre-defined task (here diagnosing patients), and the event is cognitive as it represents the dynamics involved in decision-making, problem-solving and general organisational task performance. In other contexts, with less well-defined tasks and goals, unclear situational boundaries and no obvious beginnings and ends, the method has its limitations.

We have combined an interactivity perspective (IP) with extended dialogism (ED) in order to ground human action in an ecological framework. Situation-transcendent dynamics (non-local conditions inherent in habits on a longer time-scale) affect local organisation in interaction, which we have theorised in terms of "double dialogicality" (Linell 2017). This framework should assist existing approaches within the field in adapting their methods to the foundational assumption that the non-local is an attractor for local behaviour as multiple timescales permeate local interaction (Thibault 2011, Pedersen 2012, Kirsh 2013, Steffensen 2013, Cowley & Vallée-Tourangeau 2013, Cowley 2014, Hutchins 2014: 46, Steffensen, Vallée-Tourangeau & Vallée-Tourangeau 2016).

Our perspective is one of evaluating insights, learning and problem-solving. At a general theoretical level, we have proposed more dialectic accounts as often preferable to the over-intellectualised, logical linear models (with problems as necessarily existing before solutions, options before decisions, experience before conclusions). Real-life problem-solving follows a non-linear and sometimes rather messy route. Problems are not always salient for the involved participants; sometimes they are not defined at all, or not even present in situated interaction. Instead, observations may result in insights, sometimes by serendipity, and the insights may lead to retrospective reconstruction of a prior situation, which, in light of new information, can be re-conceptualised as a problem.

Cognitive events in the wild seem to exhibit more interdependences between experiences and the emergence of solutions, which are reminiscent of the perceptual explorations in which actions, especially when they are not aided by technology and instruments, search for meaningful gestalts and are met by the cognitively impenetrable processes of impressions of environmental affordances. People perform actions in trying to see aspects of the environment, and yet the perceptual gestalts come to us not from intentions of actions of exploration, but from affordances (Gibson 1979). Moreover, problem-solving is not primarily an individual, mental task, but rather a dialogical process that links experience and the material environment with situational circumstances and socio-historical knowledge. Although we have not focused on decision-making in this paper, we have identified anticipatory dynamics in naturalistic problem-solving; it moves forward, but often not via explicit or reflected decisions.

Acknowledgements

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Appendix

Excerpt 1. Danish original

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1. 06:29:80, ps.  (7.6) (D examines P with the stethoscope and the
                   surveillance monitor beeps)
2. 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) som sænker hans puls
3. 06:43:30, ps.  (0.4)
4. 06:43:70, D:   så det er formentlig derfor
5. 06:44:70, ps.  (1.8) (D listens to P's lungs)
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Excerpt 2. 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 complains 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
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