The Ecological Subject and Visual Perception

by
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In this article, I investigate the dynamical mechanisms involved in visual perception. The analysis builds on data from a study that used cognitive video-ethnography to investigate the ongoing process of visual perception in medical team performance. The article applies an ecological approach to visual perception. An ecological approach embraces a phenomenon in its wholeness – that means as part of a larger system than that which appears in real-time. The focus on visual perception is therefore expressed as an interest in whole-bodied coordination, which on the one hand is guided by social norms for coordinating behavior, while on the other hand it is intrinsically context-sensitive. In that view, the subject is a unique historical person with quasi-objective perceptual capabilities due to previously-identified forms of sensorimotor engagement with the world. In the analysis, I show how a doctor's visual perception is shaped by local interaction and historically repeated interactions, which provides him with a professional vision (Goodwin 1994); i.e. an ability to pick up relevant information directly. Based on this analysis, I conclude that in order to understand the mechanisms involved in visual perception and meaning-making in general, we should study the individual as an ecological subject that picks up information based on experience, and what is presented for him in the situation. From an ecological perspective, the world taken in isolation (the physical world) thus, becomes less important than studying the ecological world (the subject-world system).

1. Introduction: The ecological subject and the mechanisms of visual perception

One rarely considers the world at one's feet as a world at one's feet; people simply just walk. While the world is a natural, physical constraint[1] on one's path, it also continually emerges from the engagement with it: i.e. it is being molded into a functional part of the system a person constitutes with the environment. As such, a chair can be used for sitting, it can be used to stand on to reach for things high up and so on. The world becomes meaningful for the individual as s/he directly perceives information that affords specific action (Gibson 1979). The world emerges as more or less meaningful depending on the subject's ability to pick up information directly. This ability relates to (a) the subject's historical path in the world, (b) the subject's local needs and capabilities, (c) socio-cultural norms for behavior, and (d) local circumstances (what is available in a given situation) (cf. Chemero 2003). I will demonstrate this point with an example coming from a previous ethnographic study at an emergency ward (see Pedersen 2015). The example concerns a diagnostic event where multiple healthcare practitioners discussed the interpretations of a patient's X-ray image. Prior to that discussion, the expert practitioners immediately identified relevant contours on the image. The novice practitioners came to see the contours when the experts guided them and pointed out cues for perception. However, as an observer and as a non-expert, I never became able to *see* what was so clear to them: to me the picture remained a grey messy picture with no particular meaning. Even in such a rather simple situation, where the focus is narrowed down to identifying contours on an X-ray image, this mini-cosmos world was perceived radically different amongst a group of people; or put differently: the world emerged as different worlds. The various perceptions impacted directly on the actions the individuals initiated as a world affords different actions due to the various kinds of engagement with it.

Based on this idea, the aim of this article is to further investigate the mechanisms involved in visual perception and meaning-making. I argue that by treating the individual as an ecological subject that 'sculpts' the world – when at the same time the world serves as a real constraint on action – we do not have to indulge in social constructivism (the idea that we make up a social worldview rather independently of the world out there (Collin 2015)), nor in reductionism or physicalism (the individualistic and organismic idea that reduces perception to a matter of local bio-chemical processes within the individual (Gibson 1979)). As regards the latter, when optical scientists understand vision and visual perception in relation to the anatomy and physiology of the eye-brain relation their understanding is in relation to the physics of light and the retinal image. By taking the anatomist's perspective, descriptions remain at the level of cells and organs, but the perspective is unable to explain vision, i.e. *how* we see and understand the world at our feet. While all humans have similar biological capacities for perceiving the world around us, we all somehow come to see different things, as mentioned in the example before. This insight immediately demolishes the idea of visual representation as the main key to understanding meaning-making. Perception occurs whenever sensory stimulation appears, but understanding requires that an individual directly perceives information as *something.* (Gibson 1979; Noë 2004, 2010), i.e., with regard to the example, by perceiving grey messiness as ordered information that leads to a formulation of a possible diagnosis.

The world in which a person finds himself embedded is the same real world other people are embedded in. The world, however, does not fully emerge as a static representation, disconnected from the individual's experience of being in the world. An ecological approach involves two main assumptions: First, it investigates *natural* situations. Hutchins encourages researchers to study phenomena in the natural, i.e. 'in the wild':

> The phrase "cognition in the wild" refers to human cognition in its natural habitat – that is, to naturally occurring culturally constituted human activity [...]. 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. (1995: xiii-xiv)

Second, an ecological approach embraces a phenomenon in its wholeness – that means as part of a larger system than that which appears in real-time. Thus, from an ecological perspective, studying the world taken in isolation (the physical world) becomes less important than studying the ecological world (the subject-world system). On such an ecological view, the basic methodological concern is to investigate how the system regulates the subject-world relation in order "to understand how organisms make their way in the world" (Reed 1996: 11). In this introduction, I therefore present an ecological approach to visual perception based on Gibson's (1979) and Goodwin's (1994) theories of visual perception. An ecological approach to visual perception involves investigations of how the individual moves on by engaging with the environment: "we look around, walk up to something interesting and move around it so as to see it from all sides, and go from one vista to another" (Gibson 1979: 1). If we take this perspective seriously, we automatically ask how situations, or 'the world at our feet', are perceived to expose the relevant mechanisms and constraints involved in visual perception. Before this is elaborated in the analysis, I outline these assumptions behind an ecological approach to visual perception as they impact on how I analyse and approach the data material.

With Gibson, I reject the idea that we perceive the environment with our eyes only:

> 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: 1)

When seeing is treated as a whole-bodied operation (Gibson 1979; Noë 2004), mental representation can no longer serve as the key to understanding visual perception. Gibson was therefore interested in how humans observe, encounter, perceive and act in their local environment, in order to show the automaticity with which they operate in meaningful ways. However, he was not explicitly interested in explaining the historicity of perception, nor in its symbolic or cultural aspects; he was focused on the ecological timescale we can observe during natural real-time perception. The 'ecological timescale', in a Gibsonian sense, is linked to the process of local experience:

> 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. [...] [E]mphasis 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: 12)

Pedersen and Steffensen (2014) have argued how Gibson's ecological approach to perception expanded the perceptual system in space (whole-bodied experience) but not in time (the habitual experience, norms for behaviour etc.). Therefore, Gibson derives his explanatory power from what happens in an organism's physical encounter with the local environment. Contrary to this local-time view on perception, Goodwin (1994, 2002, 2003, 2007) incorporates sociological aspects of how the world, or the environment, affords various perceptions amongst different groups of individuals. In an analysis of how archaeologists determine the values of a sample of dirt, he links situated cognitive operations of professionals to processes of classification that guide relevant action-perception cycles towards realising a functional and shared outcome in real-time. He exemplifies this line of thought by showing how archaeologists use coding schemes to provide equivalent observations in a way that literally transforms nature into culture:

> [B]y using such a system, a worker views the world from the perspective [the system] 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 colour 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)

The dirt archaeologists investigate, is literally the world at their feet. While such dirt appears in multiple details, nuances and meaningful categories, it remains just dirt for the untrained eye. The mechanisms that enable this consensual result are shaped when repetitive action-perception processes sculpture categorical patterns and forms over time. Through practice, expertise emerges, and the repetitive processes provide the practitioners with a "professional vision" (Goodwin 1994), an expert view that often materialises as "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 analysis in section 3, I therefore link Goodwin's term "professional vision" to Gibson's "visual system", in order to describe how perception is embedded in an extended space-time. That means that what a doctor sees is constrained by his level of expertise, expectations of what to see, and real-time dynamics. In other words, perception is both socially pre-organised through material-cultural artefacts and the implementation of procedures and narratives, and it is dynamical, anticipative and situated. In summary, this perspective views the ecological subject as a unique historical person with quasi-objective perceptual capabilities due to previously-identified forms of sensorimotor engagement with the world.

An individual's sociocultural and professional background is just *one* constraint on local perception. The business of the present paper is not to state whether mental representation exists or not; rather, I am interested in exploring other explanations and approaches, given that mental representation does not take us far when we seek to understand how, for instance in this case, practitioners adapt to changes in their environment and make sense of such changes. Therefore, I will only emphasise the assumptions behind the ecological approach to visual perception which can be synthesized into two important analytical criteria when we investigate visual perception: First, perception should not only be understood in terms of representation (mental coding/decoding processes), but rather as a context-specific activity that blends norms of seeing with concrete tasks and other material features. Second, visual perception includes the whole body: moving from A to B is just as much about scanning the world at one's feet as is touching, smelling, habitual sense-making, feeling etc.

Gibson argues that individuals do not see the real world objectively; rather, they interact with it based on needs, preferences and eco-social capabilities. In the following analysis, the objective is therefore to describe in depth the dynamical mechanisms involved in visual perception.

2. *Methods and data*

The ecological perspective on perception applied here involves investigation of particular forms of coordination between subjects and their environments. The focus on visual perception is therefore expressed as an interest in whole-bodied coordination, which on the one hand is guided by medical and other social, organisational norms for coordinating behavior, while on the other hand it is intrinsically context-sensitive. In other words, the investigation of perception is just as much a cognitive as an interactional endeavor, and the research method applied should be able to detect how the subject finds its way in the world by performing flexible adaptive behavior. Hutchins (1995) encourages researchers to study such coordination in natural habitats, or with a metaphor, to study 'cognition in the wild': "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" (Hutchins 1995: xiii-xiv). With this ecological recommendation, he opens up for a cognitive ethnography that considers real processes of visual perception in messy, or complex (i.e. 'wild') environments.

In the present study, I have used data from a work that used cognitive video-ethnography to investigate the ongoing processes of embodied perception in the form of medical team performance; the work (carried out at a Danish hospital) was conducted by Pedersen (2015); it includes a large set of video-recordings of natural, medical diagnostic events in an emergency ward; interviews with relevant healthcare practitioners; and general observation of the work routines over a three-month period. As an ecological or embodied cognitive ethnography, it is also a *temporal* ethnography, because *multiple timescales* are linked in the investigations of human coordination. In accordance with the assumptions underlying theories of visual perception presented above, this entails that perception is understood as historical, multi-scalar (Malafouris 2014) and non-local (Steffensen & Cowley 2010). The ethnographic study design thus allows for investigations of particularities in interaction (how a medical team perceives changes in its environment), without leaving aside the bi-directional link between particularities and an overall cultural and organisational trajectory at a macro level (how their professional vision constrains local perception). Finally, inasmuch as an ecological and cognitive ethnography opens up for investigations of whole-bodied coordination in natural occurring situations of interaction, it connects with ecological approaches to interaction (Cowley 2011; Pedersen 2015; Trasmundi & Steffensen 2016; Steffensen et al. 2016). Such ecological approaches pursue a microscopic view on rapid whole-bodied dynamics and link those dynamics to larger socio-cultural timescales (Cowley 2011; Pedersen & Steffensen 2014; Steffensen & Pedersen 2014; Pedersen 2015). These approaches have been applied in analyses of prosody (Cowley 1998, 2009) as well as gesture and movement analyses (Gibson 1979; Goodwin 1994, 2000, 2013, 2014; Streeck 2010). The present study combines and modifies these approaches in its analysis of medical diagnosis. Specifically, it uses the method of *Cognitive Event Analysis* (see Steffensen 2013 for an elaborated definition) to identify the relevant points in the interaction that enable the medical team to maintain its focus and solve the medical problem.

The dataset used in this particular analysis comes from the ethnographic study mentioned above. Even though the overall dataset consists of multiple hours of video, the short 18-second video-clip analysed in the present article captures some of the essential mechanisms involved in visual perception. Specifically, the following case involves a medical team consisting of a head doctor, a nurse, a paramedic and a gastrointestinal surgeon from another ward. The surgeon brings with him a medical student who observes from a distance. Figure 1 visualises the setting and provides an indication of the multiple elements coexisting within the medical context.

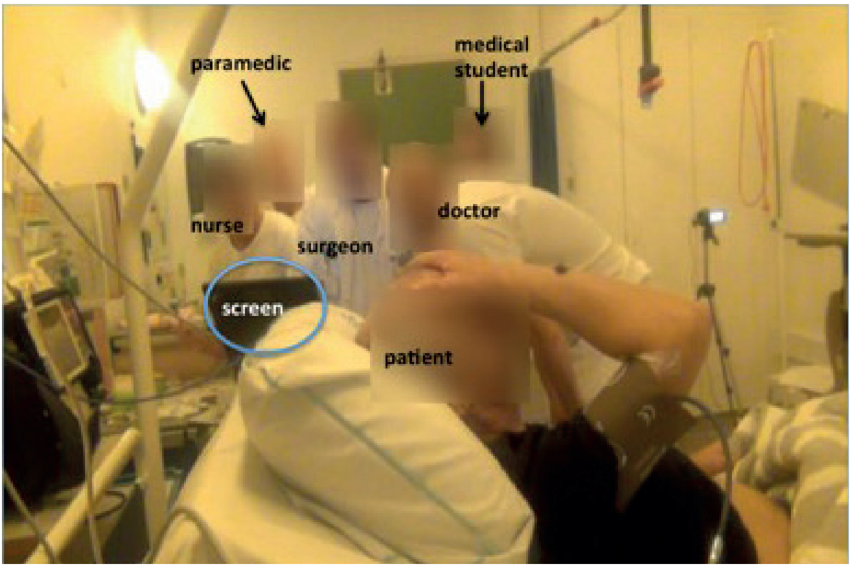


Figure 1: The practitioner configuration in the medical context

As stated in the introduction, an ecological perspective on visual perception is less concerned with *seeing* (i.e. the ability to interpret the surrounding environment, using light in the visible spectrum as reflected by the objects in the environment[2]) than with anticipating what emerges for the perceiving subject. Therefore, the analysis following here aims to reveal *which* mechanisms and constraints are involved in visual perception within a medical team, and *how* the team members coordinate their whole-bodied actions in relation to what happens in their environment. In the case in question, I describe how 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 of interaction within the environment, where the system itself is being manipulated. The case is chosen as it reveals how a team's movements constitute a shared intentionality, implying 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 to the patient.

The following analysis thus pivots on how the medical team is able to detect relevant changes in its environment and adapt to those changes, such that the goal of medical decision-making is achieved successfully. By working ethnographically, I carefully point out the special dynamics that the team picks up on in the interaction. Prior to the actual analysis, a bit of context is provided to describe *what* changes emerge; subsequently, I analyse *how* the team adapts to those changes.

3. *Analysis*

3.1 Contextualising the event of medical hypothesis generation

As we enter the interaction, the medical team is busy interpreting medical values on a computer screen. The patient lies in bed and is in pain. He arrived via 911[3] with tremendous stomach cramps and the two doctors explicitly evaluate the results of various tests that just have appeared on the screen. They provide different hypotheses in order to come up with a coherent diagnosis and strategy for further treatment. The nurse is occupied with medical measurements, reporting, and with following general procedures. The paramedic and the medical student observe from a distance, being loosely affiliated to the medical system that is organised around the two doctors and the computer screen. Figure 1 shows to what extent diagnosing is concerned with dealing with the 'surrogate patient'; as the real patient lies in bed, disconnected from the medical team, the team focuses on symbolic representations of the patient's medical condition on the screen. This organisation is unavoidable since valuable test results, previous medical documented information and so on appear only on the screen. However, the organisation is at the same time potentially critical, as it leaves the real patient to himself at crucial times during diagnosing. Actually, successful diagnosing is also concerned with how sensitively a team is able to balance artefact-scaffolded medical reasoning and interaction with the patient. 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 investigation does by describing the mechanisms involved in whole-bodied visual perception in relation to the team's overall task, which concerns effective diagnostic interaction while maintaining a constant overview of the patient's local, medical condition.

The medical team focuses its attention on the surrogate patient: by gazing at the screen and momentarily at each other as they remain focused on the medical discussion. While this is crucial to successful task performance, the team members also need to be able to react to the slightest change in the real patient's condition. As his medical condition is critical, the team's focus of interest will change with any negative changes in his medical condition. Within the team, there are different dynamics that are characterised by more or less autonomous connections. For instance, cognitively the nurse is more loosely associated with the team than are the two doctors. The nurse is primarily occupied with the completion of individual procedures; in this excerpt, we observe that she does not pay too much attention to the task of the doctors, and instead focusses on the completion of individual sub-tasks. Her sub-tasks involve patient contact, documentation and clinical tasks, such as preparing for tests, which means that she moves around in the location.

In the excerpt, I zoom in on the nurse's movements as they are crucial to changes in the overall system. During the medical interaction, the nurse walks towards the patient sphere, and by doing so she manipulates the head doctor's visual array, in a way that changes his environment and hence his possibilities for functional task performance. Thus, the nurse's 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, as shown in Figure 2 and the accompanying Pictures A, C, and L.

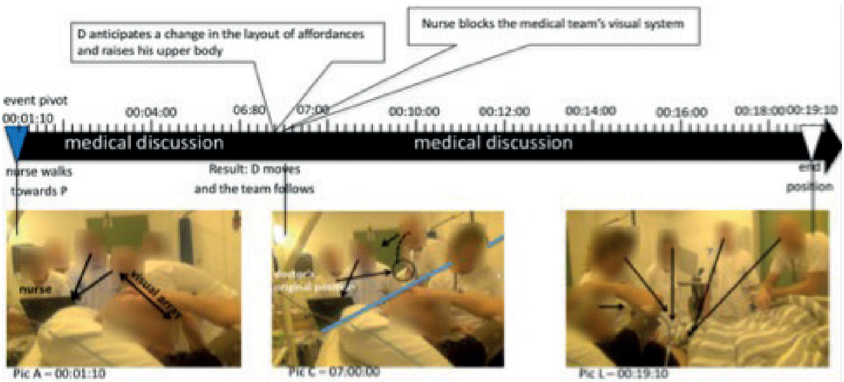
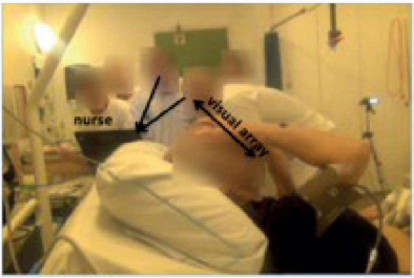


Figure 2: System reorganisation and interactional focus
The blue triangle indicates the moment – here termed as an event pivot (Steffensen 2013) – in the interaction (coincident with the nurse's movements) where the medical system initiates significant behavioural changes. The grey line in Picture C visualises the doctor's blocked visual access to the patient .

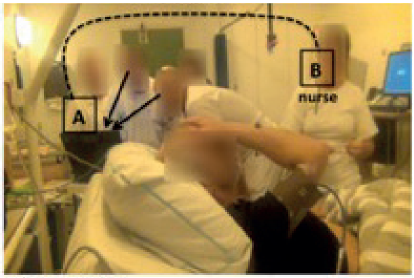
Figure 2 shows how the nurse's movement prompts the medical team to move and recalibrate its boundaries without changing tasks and without losing the overview of the entire situation: they continue the medical discussion and hypothesising, and the one doctor's movement is only functionally related to the movement of the nurse. The reorganisation takes 18 seconds and leaves the medical team with the best work conditions with a minimum of cognitive effort (see Picture L). The remaining questions are: What does the doctor perceive that makes him change position? And what are the mechanisms that enable him to perceive a change in the dynamical relation and anticipate the consequences such changes in the layout of affordances entail? The first question serves as an organising principle for the analysis, which reveals important features of the second question, to be elaborated further in the discussion in Section 4.

3.2 Moulding the optic array through locomotion: What does the doctor perceive?

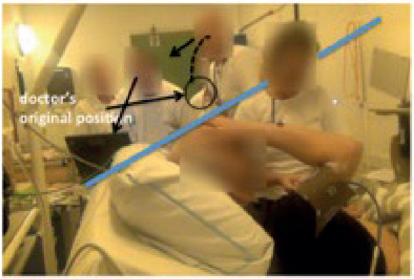
Methodologically, I zoom in on the small-scale dynamics of the doctor's adaptive behaviour, i.e. how he coordinates his movement with the changes in his environment. In the detailed gallery of Figure 3, the overall flow of coordination is visualised. It shows the gaze, movement pattern and the visual array within the medical team. It also visualises the phase from the nurse's initial position until the medical team reorganises and finds a new work zone position. This behavioural pattern is analysed in the paragraphs following Figure 3.



Pic A – 00:01:10

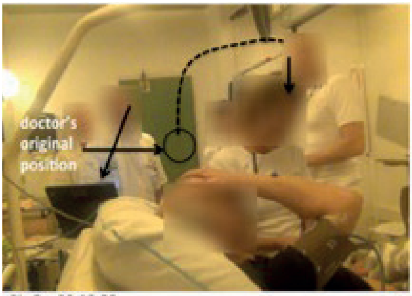


Pic B – 00:05:20



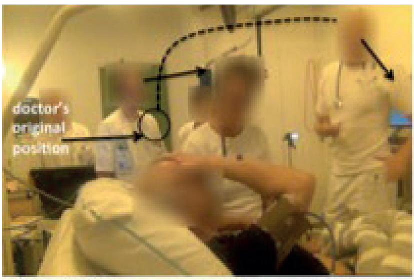
Pic C – 00: 07:00

Pic D – 00: 08:10

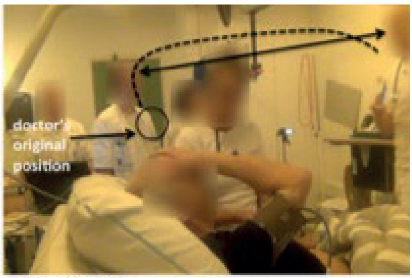


Pic E – 00:10:00

Pic F – 00:10:10



Pic G – 00:10:20



Pic H – 00:11:10

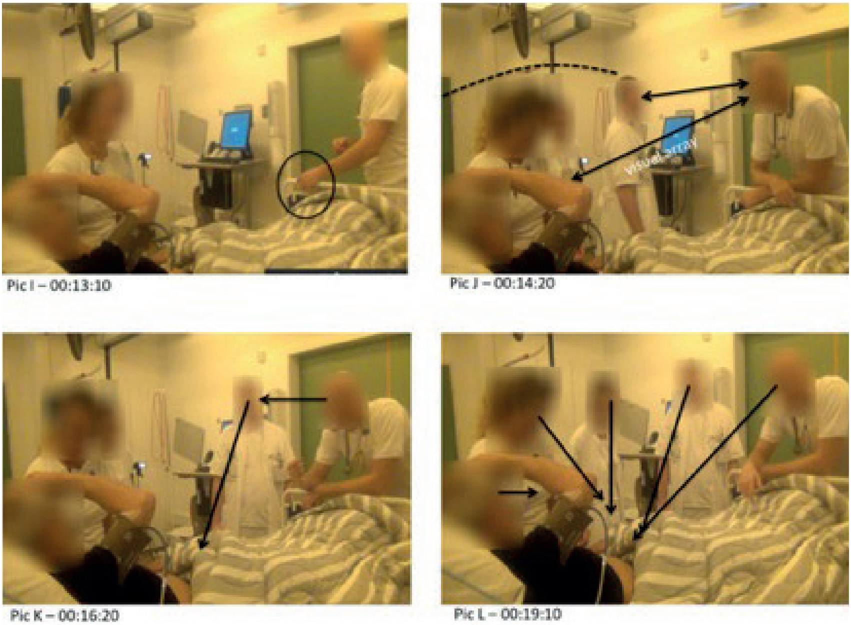


Figure 3: The gallery (Picture A-L)

In Pictures A-B, the team has full visual access to the real patient, even though they bend forward and gaze at the computer screen. However, as the nurse needs to place herself next to the patient to complete her tasks, she will eventually block the visual array of the medical team (see Picture D). She walks from the corner, around the team and towards the patient (Pictures A-C), which changes the situation from a static, calm interaction to one characterised by motion. The nurse's movements (starting in Picture A and ending in Picture D) cause a corresponding movement pattern within the medical team, i.e. her action initiates a dynamic physical change in the team constellation (see Figure 3). However, movement in one sub-system does not necessarily trigger movement in another sub-system. In the situations prior to this excerpt, the nurse has been moving in similar patterns, back and forth but without blocking the visual array between patient and team. The team, in those cases, did not respond to those actions: rather, it remained located around the screen. Therefore, the timing of the doctor's movement is crucial to understanding what prompts him to move in this particular case. First, a detailed description of the doctor's and the team's movement patterns is outlined in order to generate an explanation of the mechanisms involved.

I argue that the doctor initiates a move as a reaction to the change in the environment and as an anticipation of *potential future changes*. His movements are anticipatory in that he moves (at 6.80) *before* the nurse actually blocks the team's visual array at 7:00 (see Figure 2). In Picture C, the doctor is already moving and almost in an upright position, but the nurse is not yet blocking the visual access to the patient. However, as the nurse gets in the way and blocks the team's visual access to the patient (see Picture D), the doctor has already anticipated this visual constraint, raised his upper body and started to move backwards away from the screen even though he has never gazed directly at the nurse. 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 head doctor moves backwards *without even looking in the direction of the nurse or the headboard* (see Pictures C-D). This means that the doctor does not see the nurse's blocking and he does not *see* the end point of his movements (the headboard), he simply starts moving. Without looking in the direction of the 'problem' (the nurse's itinerary) or the 'solution' (the headboard), he anticipates a change in the interaction as a potential problem (blocking), which prompts him to act. His actions directly affect the team's working conditions. The surgeon shifts his visual attention from the screen to the head doctor as the physical distance between them increases. The team then re-negotiates the best place for solving the medical problem and the doctor marks the endpoint as he stops moving when he reaches the back of the headboard (see Picture J). The whole medical team follows and relocates. The new position enables all team members to regain perfect visual access to the patient without interrupting their medical hypothesising (see Picture L). During the 18 seconds, the head doctor has been summarising the medical history and both doctors have re-located to the end of the bed (see Picture K), and continue to evaluate the patient's medical situation. This problem-solving activity is nested within the larger medical work of generating valid hypotheses about the patient's situation.

The team's re-organisation (from around the computer – to the end of the bed) affects the quality of the visual system positively. By anticipating not only the nurse's movement trajectory (her blocking the view) but also changes in the patient domain (possibly severe changes in his medical condition), the team is continuously adapting to its environment in order to be located at the best possible place. *If* the patient's medical condition changes, the team 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 the doctor affects the locomotion of the whole team, as the other team members have not perceived any relevant changes in the environment: They remain at their initial location until the distance becomes too big for the doctors to continue the dialogue (see Picture J).

The example does not describe a problem proper; rather it conveys anticipation in the form of a negative feedback mechanism that prevents a potential problem from emerging. This feedback mechanism reveals a meaningful locomotion-probing rather than explicit goal-orientation (Steffensen 2013; Cowley 2014b). Given the head doctor's formal role as the main responsible within the team, he has different obligations than has the gastrointestinal surgeon. The latter's professional relationship to the patient is primarily characterised by its bio-medical focus on a specific body part (the abdomen), whereas the head doctor is also responsible for patient interaction and general clinical tasks. These different roles entail different foci within the medical team. Institutionally the surgeon is not the main responsible for the identification of the change in the broader environment as a relevant affordance for action. This is the job of the head doctor. On the other hand, the surgeon needs to and does also anticipate the movements of the doctor, and those organisational norms and procedures serve as constraints for their visual perceptions. The example points up how the same physical environment provides both shared and distinct affordances for the medical team's actions. The world at their feet is shared and meaningful only in relation to the task they attend to and their specific roles and responsibilities. The doctor perceives the nurse's movements as an affordance for re-locating the team's position, and the surgeon likewise perceives the doctor's movements as an affordance for moving in order to maintain optimal conditions for the medical problem solving. In this way, their qualifications and competences, built up over time, saturate their local action-perception cycles and decision-making. The world at their feet becomes a functional world, where the information they pick up reflect their organisational position and level of competence.

4. *Discussion: The historical body, the flow of perception, and timescales*

By considering how longer, non-local timescales serve as a constraint for the local here-and-now, it becomes possible to investigate how inter-bodily dynamics mesh with social orderliness, and also how perception is shaped by materiality and historical experiences as prerequisites for seeing useful action patterns and enacting intentions. Nothing in the data indicates that there exists a local plan or specific calculations that afford the doctor to think of how the visual system works most effectively. As mentioned in the analysis, he does not even *look* in the direction of the nurse or the patient's headboard as he initiates the backward movements (see Pictures C-D); rather, he *perceives* the nurse's reorganisation as an important change in the layout of affordances that prompts him to move. In other words: his skilled, historical body functions as a visual detector of affordances that enable certain actions. The whole act, thus, makes perfect sense, since the re-orientation results in an optimally shared medical system where the team's visual array works to the best effect.

The ease with which the head doctor anticipates the potential problem can be explained by the power of the subject's micro-social ecology, which transcends local interaction (Steffensen 2013, 2015; Pedersen & Steffensen 2014; Steffensen & Pedersen 2014). His repeated structural coupling with relatively stable medical teams equips him with an embodied professional history (Goodwin 1992; Noë 2004). We observe a case of anticipatory sense-making that is grounded in the bio-cognitive historical body. Though the notion of whole-bodied vision has been emphasised again and again, it still needs to be empirically tested and developed:

> 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. [...] [T]heory 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 due to their developed professional vision. Therefore, as we observe in this example, visual perceptions are *not* explained as processes of representations or verbal embodiment with a gestural function; they are automatic, enabled by the developed ability to pick up relevant information in the world at their feet. Since the position 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 conditions allows it to anticipate potential problems without reducing the level of cognitive capacity and focus.

From a dialogical perspective, the team 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 reveals the core dynamics of human action and perception. By emphasising the spatio-temporal, dialogical and embodied aspect of sense-making, we observe 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 physician, whose 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 *calculating* where the right place is. His actions are not explained as accidental and random but rather habitual and sense-saturated[4] (Steffensen 2013). Merleau-Ponty argues that perception is less about explicit calculation than about 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: 144-145)

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 also with an extended experience that transcends 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 does the medical expert and hence moves differently. For instance, in the ethnographic study from which those data come, Pedersen (2015) showed how novices often are in the way; their movement are clumsy and abrupt; and they have no direct feeling of where the right place to be is; and finally, they are unable to anticipate what comes next and move in accordance with such anticipation.

The excerpt above confirms Noë's (2004) 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), whereas it has often retrospectively been explained as a logical and mechanistic process, as if it happened in a vacuum with clear boundaries and a start and an end. Compare the following quote from Bergson:

> 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. However, according to Dewey (1910), a cognitive system is enabled to act functionally according to the changes in its environment that are due to the information the system has gained over time. In other words, the team's coordination of movement is sense-saturated (Steffensen 2013) and different from random movements.

Random action does not necessarily manipulate anything; thus timing, coordination and co-action are fundamental criteria for successful and purposive manipulation and recalibration. Such criteria require that we investigate the adaptive flexibility of human body-artefact systems rather than the behaviour of individuals in isolation, separate from their world. 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 maintains 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). Therefore, the doctor was unable to describe his movement path. When he left the patient sphere, he could not explain why he moved nor could he recall the movement pattern. In this way, the team's movement can be explained as embodied, skilled, and saturated with tacit knowledge.

5. Conclusion

As emphasised at the beginning of this paper, 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 task performance (Goodwin 1994; Gibson 1979). With a famous saying from Nikolaj 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, while the actions are adjusted and adapted to the situation. In this ecological 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 a successful realisation of values that is effected in ecologically real environments, in this case diagnostic processes in emergency settings, where practitioners are subject to unpredictable changes (Ito 2011). Plausibly, because the doctor has been involved in a number of emergency situations where the patient's condition suddenly worsened, his embodied historicity of being alert provides him with the ability to see small-scale changes that reduce his visual array, no matter how unimportant such small-scale changes might appear. Though each particular situation varies in many respects, the task (and momentarily the constraints) often take on similar appearances. Repetition without repetition is sense-saturated (Steffensen 2013), and allows for flexible behaviour in goal realisation. If the movements were not sense-saturated, the goal would not be achieved in such a smooth and coordinated way.

In the analytic part above, I have shown how perception is altered by an individual's ability to adapt flexibly to changes in the layout of affordances (Gibson 1979; Noë 2004). Thus, *purposeful movement* becomes an important strategy for manipulating the subject-environment system. Expertise shows in the embodied automaticity where activities are characterised as fluid and effortless adaptation (Merleau-Ponty 2012; Dewey 1910). When practitioners have different cognitive resources for diagnosing and treating patients, their professional visual systems operate on the basis of different kinds of experience, personality, or situational factors. This variety leads to very different processes of behaviour, but also to different sensitivities towards elements in the environment. The team moulds the optic array, and their joint movement serves as a negative feedback mechanism whose successfulness is defined by the anticipatory intentions that facilitate fluid and smooth task performance. The success of this team relates to its cognitive abilities to align verbal utterances (a cognitive agenda of hypothesis generating) with movement (securing visual contact with the patient). Much seems to be encountered and anticipated in a way that feeds back on the interaction, such that it never appears to be a problem at all.

Understanding the processes of becoming a master within a discipline is key to facilitating and scaffolding the learning process. If repetitive situations and task performances reshape our perception and make professionals revise their concepts and thinking in general (Kirsh 2013; Noë 2004), we need to show *how* this happens. Importantly, developing a visual system can happen in many ways: through intuition-based probing, but also by letting an experienced practitioner guide a novice (by facilitation). Finally, visual perception has less to do with processes of representation than with being aware of how and what can be manipulated (Gibson 1979; Noë 2004, 2010; Pedersen & Steffensen 2014). Therefore, the first step in improving our understanding of how individuals solve tasks is to acknowledge that the world at our feet is also the world at our hands, our mind and our past and future. In other words, the real, physical world is only to a limited extent shared.

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Notes

1. I use the concept 'constraint' to underline that something controls (to some extent) what one does by keeping oneself within particular limits. When the world is a natural constraint on one's path it literally means that the physical world to some extent defines the path you can take when you move forward. Trails and roads mark a natural route when walking. Water and mountains obstruct your path. However, navigation is not only constrained by the physicality of the world but also by our history of being part of the world. That means that our habits, our knowledge and skills of how to move forward etc. also serve as a constraint for good and for worse. Being a backpacker, for instance, enables you to detect specific challenges in the physical world that are invisible for the untrained backpacker; so, two people may not follow the same path in walking toward a certain endpoint. That said, no one would be able to walk on water or jump over 'unjumpable' distances.

2. I fully acknowledge that the two processes (seeing and anticipation of what emerges) are closely connected. However, the analysis builds on the assumption that the ecological approach, by studying how people make sense in their world by adapting their bodies to changes in the environment, captures the central mechanisms of this adaptation, and in that sense, processes in the visible spectrum become less relevant. If the aim were to examine the eye as an organ (how cells in the retina works for instance – as the physiologists would do), a physicalist perspective would seem beneficial – but if the aim is to study what the eye can do, i.e. how the visual system operates, this perspective reaches a dead end (cf. Gibson 1979: xiii).

3. 911 is an emergency telephone number. The number is intended for use in emergency circumstances only.

4. Steffensen (2013) introduces the term sense-saturation in order to explain how human individuals are living historical bodies. That means that every person is always saturated with experience, meaning (i.e. the sense), that provides the individual with a direct understanding of what happens. The sense emerges on multiple scales and is enacted in local situations. The enactment is seen as particular, direct meaningful actions (that we can communicate through language; that we know how to examine a patient; or even in how we are supposed to move around to be efficient). The sense is therefore a lived, embodied meaningful situation that shapes the individual and equips it with capabilities for knowing *how* in new situations.

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