"No user is an island"
Onlookers, affordances, and the impact of mobile devices on work practices

Completed Research Paper

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Abstract

This paper addresses the question of how the use of mobile devices impacts work practices, based on an ethnographic study of the use of iPod Touch devices in operating rooms. Building on the concept of affordances in its recent conceptualization as "multifaceted relational structures", we analyze the interplay between different affordances of iPods seen from the perspective of the user (who is interacting with the device), and from the perspective of the onlooker (who is interacting with the user, but not directly with the device itself). The analyses reveal that while the use of the device clearly had a function in supporting individual work practices, it negatively influenced the implicit coordination required for the interactive work practices. By including the onlookers' perspective, we provide a more complete picture of how affordances are shaped and enacted within the social context of multiple relations and how this enactment further impacts work practices.

Keywords: Mobile technology, affordances, work practices, onlookers.

Introduction

Mobile devices are increasingly being used in both organizational and private settings, and are increasingly impacting the way we work and interact with each other. With the increasing use of various mobile devices in organizations (either users' own devices or provided by the organization), a relevant issue that emerges is how the use of such devices impacts work practices. This issue is central to this paper, as we focus on the question how the use of mobile devices impacts individual and interactive work practices. *Individual* work practices concern a single actor's tasks, whereas *interactive* work practices involve collaboration and coordination between two or more interdependent actors. For our analysis, we focus on the different affordances a mobile device can have for the *user* (interacting with the device in his or her individual work practices), and how these affordances are inferred and perceived by *onlookers* (interacting with the user in interactive work practices, but not directly interacting with the device itself). The interplay between user affordances and onlooker inferences, we argue, determines the impact of mobile devices on interactive work practices in particular.

Affordances are seen as "possibilities for action" created in the interaction between user and technology, within a larger context of multiple relations between roles, practices and lines-of-action (Faraj and Azad 2012, p.254). We analyze mobile technology affordances using an ethnographic case study of interaction between operating room nurses who are involved in an interactive work practice. The sterility requirements of operating rooms dictate that one of the nurses (assisting surgeons at the table) is sterile and another one (who is in touch with the "outside world") is non-sterile. Where this non-sterile nurse is able to use a mobile device when there is a spare moment to do so, this is not the case for the sterile nurse. This role distribution created two different yet related interactions – a user interacting with a mobile device, and a (temporary) non-user or *onlooker* interacting with the user in a highly interdependent situation. Analyses of these interactions revealed that affordances can be seen not only from the perspective of the user, but also from the perspective of the onlooker, even though the onlooker is not directly interacting with the technology. We find a process of reciprocal inference between users and onlookers – onlookers infer what users are doing on the device (which affordances they enact), and the user, in turn, infers how the onlookers interpret this use. These interpretations then influence users' own perception and enactment of these affordances. By including the onlookers' perspective, we provide a more complete picture of how affordances are enacted in the interaction with mobile devices, and how they impact work practices.

The paper is structured as follows. We start with reviewing the literature on technology in use, arguing for the necessity of including the role of the onlookers, and introduce the relational concept of affordances as a way to do that. Next we describe the work practices of operating room nurses and distinguish between user and onlooker perspectives on mobile technology affordances, and explain how we collected our empirical data in this setting. We further show how this onlooker perspective can have consequences for the use and impact of mobile devices in the interactive work practice. We conclude with discussing our theoretical contribution, limitations and suggestions for future research.

Theoretical background

Research on technology and organization has long shown the importance of the social context in understanding how technology is used in work practices. Indeed, the very terms "social construction of technology", "sociomateriality", and "sociotechnical systems" imply that to understand how technology gains meaning and is used in practice, unraveling "the social" is important. What is implied by "the social" varies among authors. Social construction of technology scholars, for example, concentrate on the role of designers and key actors who participate in developing technology and inscribe political and cultural schemas into technological designs which ultimately influence technology appropriation (Pinch and Bijker 1984). In structurational theories of technology, the social context is represented by the institutional environment and organizational norms that together with the user's agency reiteratively shape and are shaped by use of technology (Barley 1986; Orlikowski 1992). Within the technological frames approach, "the social" is conceptualized as "collective frames of reference" about technology, and analyses focus on how these frames influence technology use (Davidson 2006; Orlikowski and Gash 1994). A very recent view is the technical identity approach, explaining how the identity of a technological object is dependent

on the function assigned to it based on social rules and routines, as well as on its physical characteristics (Faulkner and Runde 2009; 2013). Combined, the accumulated debate and evidence from existing IS theories acknowledges and convincingly demonstrates that technology use does not take place in a vacuum, but rather is shaped by social contexts, including culturally and politically layered intentions of designers, social communities, routines, norms and other institutional properties.

There is, however, one important assumption that limits our understanding of the social context in most of these theories: the focal actors and units of analyses are *users* interacting with technology[1]. Indeed, this is a logical starting point to understand technology in use. However, users interact with the technology in the presence of others, who are not necessarily users themselves, and who do not always belong to the same or related occupational community. Making the user perspective a central unit of analysis inevitably creates an incomplete picture of technology use, as if users are interacting with technology in a vacuum after all.

Including the "others" (i.e., non-users) in the analysis is especially relevant in the study of mobile devices. Users interact, work, play and communicate on their personal mobile devices (phones, tablets, etc.) everywhere and anytime, which relocates technology use to various physical contexts (trains, restaurants, home) that are often not directly linked to what the technology is used for (Lever and Katz 2007). In addition, mobile devices can lead to both engagement as well as disengagement with work practices, colleagues and others (MacCormick, Dery and Kolb 2012). Increased flexibility, autonomy and coordination, for instance, can lead to more engagement, whereas antisocial behaviors, absent presence (Gergen 2002), over-communicating and problems with maintaining boundaries (Hislop and Axtell 2011) can negatively influence engagement, affecting both work practices and social relations. Medical practitioners, for instance, struggle with the fact that the use of mobile devices can be perceived as annoying by patients or as unprofessional by colleagues (see a see a panel discussion among American Orthopedic Surgeons, 2012). Patients on blogs complain about their doctors being constantly checking their iPhones and not being concentrated (see blog posts on "distracted doctoring" by Thomas (2012)). In other contexts, such as education or family, it is also often discussed that mobile device use triggers many negative emotions from the others (e.g. Rimer 2009). The perceptions of these "others" become especially relevant when these others are directly involved with the users in interactive work practices, and are physically present in the same room as the users.

The distinction between individual and interactive work practices is based on the extent to which different actors are involved in a work practice, and the extent to which these depend on each other. Where an individual work practice primarily involves a single, independent actor, an interactive work practice involves two or more actors who are interdependent. Where the use of a mobile device in an individual work practice would only concern the interaction between user and technology, the use of such a device in an interactive work practice involves user, technology, and the "others" – the other actors involved in the work practice. We are specifically interested in the role of these others when they themselves are not users of a mobile device – i.e., they are *onlookers,* interacting with the user in their interactive work practice, but not interacting with the device themselves.

In order to bring onlookers into the discussion of technology use, we build on the concept of *affordances*. Originally, this concept was introduced in ecological psychology as a way to bridge cognitivist views of objects existing separately from the species who perceive them (Gibson 1979). An affordance is not a feature of a technology but an opportunity for action that emerges from an actor interacting with a technology (Faraj and Azad, 2012, p. 238). A technology presents different opportunities for action to different actors, in different contexts. The affordance approach has grown to be quite popular in research on technology and organization (Leonardi 2011; Markus and Silver 2008; Norman 1988; Zammuto et al. 2007), as it helps overcome the traditional dichotomies (subject-object, agency-structure, social-material) that have stifled much of this research before (Leonardi and Barley 2008; Faraj and Azad 2012).

It should be emphasized that affordance is essentially a *relational* concept: the action possibilities emerge in relation to an individual actor, are created in the relationship between actor and artifact. An exclusive focus on this actor-artifact relationship, however, tends to under-emphasize the social aspect of affordances (Azad and Mesgari 2013; Costall 1995; Hutchby 2001): the relationship between actor and

[1] Designers are a different unit of analysis, but designers are separated from users in space in time. Moreover, analysis of design mode of technology does not address the questions of how technology is used in practice (see critique of SCOT by Winner,1993)

artifact is embedded in a larger set of relationships with the social context. This social context also shapes affordances, for instance through social meaning and conventional rules regarding use (Fayard and Weeks 2007), and organizational routines, procedures and norms (Zammuto et al. 2007). Both these aspects of the relational character of affordances are emphasized in Faraj and Azad's (2012, p. 255) definition of affordances as "multifaceted relational structures", which are "realized via the enactment of several mutuality relations between roles, line-of-actions, practice or routines that influence the relations between technology artifact and the actor, which is situated and emergent in practice".

The relational character of affordances enables us to focus both on the relationship between user and technology, and the relationships with others in which this relationship is embedded. Thus, the affordance perspective enables us to include the perspectives of onlookers, i.e. non-users who are witnessing and thereby influencing the use and impact of a technology. Building on this, we need to analyze the different affordances a mobile device can have from the perspective of both the user (interacting with the device in his or her individual work practices) and the onlookers (interacting with the user in interactive work practices, but not directly interacting with the device itself), how these perspectives help shape these affordances, and the way these affordances impact work practices.

In the following section, we describe our research setting, data collection and analysis procedures. When describing the setting, we dwell on micro-specifics of interaction between nurses during a surgical procedure to provide a rich picture of their work practices and reveal the context in which affordances are perceived by users and onlookers. Such an analysis responds to the call of analyzing "how the specific action unfolds in that unique moment and situation, whom and what it enrolls, and how it affects the world" (Faraj and Azad, p.255).

Method

Research setting

We conducted an ethnographic in-depth study at Department of Anesthesiology and Operative Care at a large medical hospital in the Netherlands, where a specific group of employees (Assistants) in the operating rooms (OR) department initiated the introduction of mobile devices into their daily work practices. The department has about 200 staff members: OR nurses, anesthetists and anesthesiologists. The department provides surgery time, room and assistance services to other specialty departments of the hospital. Different surgeons can book an OR to perform their procedures. Overall, 16 operating rooms are functioning 24/7, covering most surgical specialties, including neurosurgery, major trauma and emergency operations.

The hospital was chosen because it provided an example of a context where mobile technology was recently introduced into work practices. In 2010 the department of Anesthesiology and Operative Care launched a so-called "iPod project", which was mainly initiated by a group of OR employees: two anesthetic assistants and one OR assistant. Annoyed by problems with accessing necessary documents (such as operation procedures, information on medication, lists of equipment needed for surgeries, and notes on surgeons' preferences for surgical materials) in distant areas of the hospital, and lost in abundant paper documents, these employees collected all the necessary information from the department's intranet and created a digital library on their own private iPod Touch devices. With the small format, the easy-to-use interface and the touch screen, this device was expected to enable fast, flexible and accurate access to all the necessary information. Management became committed to the initiative and was willing to invest in providing other OR employees with the same device to "optimize overall work processes", through a budgeting scheme which enabled OR employees to apply for an iPod Touch and pay for it from their personal "learning and development budgets". The "iPod project" was enthusiastically received by OR employees and the majority of employees applied and received an iPod Touch. Over the course of 18 months, the iPod Touch became an indispensable device for the OR staff. The iPods were introduced into the practices of anesthetic assistants (assistants of anesthesiologists) and OR assistants (scrubs and circulating nurses who are assisting surgeons); the introduction did not concern doctors, i.e. surgeons or anesthesiologists, who form separate occupational groups.

Data collection

The data collection relied primarily on non-participant observation and in-depth interviews. The observations were conducted in three rounds – 16 days in March-April 2012 (18 months after the introduction of iPods into the practice), 10 days in July-August 2012, and 5 days during March 2013.

These three periods reflect the development in our focus during this study. The first period of observation was mainly aimed at an assessment and analysis of the impact the iPods had on the overall efficiency of work processes in the OR. During our analyses, we encountered interesting findings in terms of the actual work practices our subjects were involved in, and their non-work related use of the devices. Our second period of observations was meant to delve deeper into these issues. Analyzing these findings, the difference between users and onlookers came to the fore, and we went back for a third period of observation to further study these roles and validate the findings we got from the first two periods of observation.

The first author of this paper shadowed OR nurses and anesthetists, observed the preparation and execution of actual surgeries in the operating room, followed staff into storage and adjunct rooms, as well as to the lunch room during coffee breaks and meals. Overall, 57 surgeries were observed and approximately 197 hours of observations conducted. While observing the researcher also had a chance to ask questions for clarification and engage in multiple informal conversations with employees. At the end of each day field-notes made during the day were transcribed into explicit detailed narratives. These combined narratives make up for a 103-page ethnographic story.

In addition, 64 semi-structured interviews were conducted with employees of the department, covering OR nurses, anesthetic nurses, surgeons, IT staff and managers. The interviews were conducted in three rounds, during the same periods the observations took place. In each period, different people were interviewed. The sampling logic was aimed at covering the diversity of employees in terms of tenure, function, position, gender and hierarchy. During interviews we asked OR employees to describe how they experienced the introduction of the iPods in their work, the functions they mostly used and enjoyed, and problems they might have encountered in their use of the iPod. Because we continued to analyze data iteratively while conducting interviews, our questions in the last round became more focused on interpretations respondents made while observing their colleagues using the device, reflecting the shift in our focus from process effects to the interactions between user, device and onlooker. The interviews were recorded and fully transcribed. We used the Atlas.ti software package to structure and code the fully transcribed interviews and field notes.

Data analysis

We analyzed the data using grounded theory procedures (Strauss and Corbin 1998) in terms of open and axial coding. The open coding procedure consisted of two steps. In the first step, we focused on unpacking the OR work practices to provide the description of the context in which the user was interacting with the device. We produced several narrative memos revealing the content of OR work practices, including descriptions of each role (circulating, scrub nurse, anesthesiologist, anesthetic nurse, surgeons), typical (manual) actions of each of the team members during an average surgical procedure, sequences of these actions, etc. We also produced several visual graphs representing the relationships between team members and coordination practices. We discussed and rewrote these memos and graphs multiple times to arrive at a concise, clear description reflecting the regular patterns of OR nurses practices.

In the next step of open coding we went through the data with the focus on instances in the data that mentioned how the iPod was normally used in practice. We then grouped these instances into 6 groups of uses: retrieving work-related information (e.g. workbooks), communicating professionally (e.g. email), taking pictures and videos, communicating recreationally, surfing the internet, and killing time (e.g. playing games, reading news).We then reviewed how these uses were described or performed by respondents and following Glaser and Strauss' (1967) comparative method looked for similarities or differences across those cases. We observed that respondents often described their own use differently than the use by others and these accounts were often contradictory. Upon this finding, we sorted the data again into two broad groups, distinguishing a "user perspective" and an "onlooker perspective".

The aim of axial coding was to arrive at an understanding of how iPod use influences work practices,

which was in line with the theoretical aim of revealing the relationships between user, technology and context. We juxtaposed the user and onlooker perspectives on the iPod's affordances and the broader context of OR work practices. During this step the distinction between *individual* and *interactive* work practices emerged, as well as the specific affordances of iPods (accessibility of information, visualization, connectivity, entertainment, invisibility). During this stage of analysis we also conducted the final set of interviews in which we specifically asked interviewees to elaborate on onlooker and user interpretations and the consequences for their either individual or interactive work practices. In the following section we examine the identified relationships in detail.

Findings

Setting the scene: what happens in an operating room?

We first provide a description of the work practices the operating team is involved in. This description serves in later sections as a background for distinguishing the roles of onlooker and user, and analyzing their perspectives on and enactment of the iPods' affordances.

An OR team usually consists of two sub-teams – the anesthesia team (usually one anesthesiologist and his/her assistant) and the surgical team (usually 2-3 surgeons and 2 OR assistants). The focus of our analysis is on the work practices of the surgical team, since this is where the interaction between users and onlookers manifested itself most strongly. The area of the OR is divided into sterile and non-sterile sections. The sterile section is the area with an operating table with the patient and an area around it (which they call "sterile island"). After the patient is brought into the OR and anesthetized by the anesthesiologist, the sterile area is only accessible to the sterile personnel: the operating surgeons and one OR assistant (called *scrub nurse*) who are thoroughly washed before the procedure. The patient is covered with sterile cloth and anything that comes close to the sterile area is subject to very strict hygiene requirements. The area outside the island is subject to less strict hygiene requirements: in order to enter an OR, one should wear a face mask, a hair cover, and special scrubs (not wearable outside the operating unit), but one only needs to be washed (scrubbed) when approaching the sterile island. It is also allowed and widely practiced for non-sterile staff to carry some small personal objects on them such as glasses, phones or books. The non-sterile area in the room is occupied by the anesthesiology team and the second OR assistant (called *circulating nurse*). It is important to note that OR assistants can perform both (scrub and circulating) roles, and during the day they typically switch the roles, to have a variety in their tasks and allow each other a break. Depending on the difficulty and specialization of a surgery, on average the team performs from 2 to 4 surgeries a day in one OR, which allows assistants to switch at the table once or twice a day.

During the surgery, the operating surgeons collaborate closely with a scrub nurse who inserts instruments into the surgeon's hand. A scrub nurse is supposed to know how the surgery usually proceeds, anticipate what the surgeon will need at the next step and supply the instruments without the surgeon having to ask for them. The scrub nurse, in turn relies on the circulating nurse to provide additional instruments or supplies when these are needed. This latter *interactive work practice* (involving scrub and circulating nurse) is the one we focus on in our analysis, because – as will be explained later – this is where the iPod plays an important role. The other members of the surgical team are not involved in this work practice - operating surgeons are completely focused on the surgery itself, and pay no attention to the interaction between scrub and circulating nurses.

Observations revealed that this interactive work practice involving scrub and circulating nurses relies on *implicit coordination*, a form of coordination that requires little or no direct communication but relies on anticipation and dynamic adjustment (Rico et al. 2008). A circulating nurse is supposed to follow and anticipate how the surgery is proceeding, *anticipating* on the scrub's needs and *dynamically adjusting* his or her individual work practices to fulfill those needs. This is reflected by how one scrub nurse describes the ideal circulating nurse: "a person who will know what I need before I have thought about it" (Interviewee 11). This implicit coordination, and the standardized and regulated segregation into occupational roles of scrub and circulating, provided an ideal case to study a user and an onlooker in a setting where their work is interdependent, but the use of technology is not.

The affordances of the iPod: the user's perspective

Observations revealed that iPod use was widespread and common among the nurses: they walked and sat with their iPods in most of the areas where they spent their time during the day – preparation rooms, storages, hallways, cafeterias and inside the operating room during surgery. However, inside the OR, there were several limitations on their iPod use, which stemmed from the sterility requirements and more generally from the nature of their practice. In particular, the mobile device could not be used by any of the sterile team members and were only used by those who were not sterile (the circulating nurses). Also, since use of the device required holding it in (at least) one hand, the iPod could not be used during most of the manual work in the OR (handing instruments, adjusting stuff, touching and working with the patient, etc.). Finally, iPods could not be used at points of other active time. For example, when a circulating nurse saw the agitated action of her team members, s/he expected that some request would arrive and s/he needed to be focused in case s/he would be needed for fetching necessary instruments or other supplies.

Because of these limitations iPods were only used during surgery by non-sterile team members and only during particular moments of the operation. These included the stable moments of the operation, when the circulating nurse was done preparing, supplying and administering, the surgery went smoothly and s/he could sit down and relax for some period of time. During these moments, a circulating nurse usually took a chair close enough to the operating table to hear how the process there was developing, took out the iPod and started peeking on the screen and/or scrolling down. The physical shape and size of an iPod required the user to slightly bend over the screen. While doing so, nurses formed a body posture that looked like the one represented in figure 1.

Figure 1. iPod use by a circulating nurse in OR

A situation as represented in figure 1 was observed almost at *every* surgery that was attended by the first author of this paper. In addition, during interviews, we showed the same picture to respondents and they confirmed that it had become a typical representation of a circulating nurse during a surgical procedure. Our findings indicate that OR nurses used their devices quite intensively, and had a strong desire to use it whenever they felt they had nothing else to do, which often occurred during quiet moments of long standard operations. Consider, for example, this illustrative observation:

> "I was assigned to observe a plastic surgery in which 3 OR assistants were involved – Sofia (senior nurse), Natalia (student about to graduate) and Julie (3d year student). The surgery was an advanced one and was expected to take 5 or 6 hours. Natalia scrubbed in and Julie was circulating. Sofia was only present during the beginning and after the 1st hour had passed without complications, left the OR to prepare for the next surgery. Julie was circulating confidently and in the beginning stood close by or sat on the chair close to the table. After the 1st hour of surgery, she started using her mobile device quite often. I could not see exactly what she was doing and also could not see if this was an iPod or an iPhone, because it was shielded by the instrument table. From her movements it looked as if she was texting or chatting online – at some points she typed something in, and at others just looked through to see as if to check for response. Because she was reaching for her device extremely often I decided to measure during an hour the times when she used her device. Here is what I got:

11:32, 11:41, 11:50, 11:58, 12:05, 12:08, 12:15, 12:20, 12:24, 12:27, 12:35"

These observations revealed that nurses developed an almost automatic habit to reach for their device and experienced a strong urge to check it. Indeed, the words very frequently used by nurses to describe how they feel about their iPods were "addicted", "can't live without it", "travels with me everywhere", "I am lost without it", "kind of a drug", etc.

In the interviews, the users primarily talked about the iPod's affordances in relation to their individual work practices. These individual work practices primarily consist of checking information, staying in contact with the world outside the OR (answering the phone, getting supplies) and waiting. A first affordance that emerged from our findings is *accessibility of information*. When asked how they use their iPods, OR assistants provided many examples of the iPod's work-related functionality and stories of how it helps them with having essential information available. They described how they regularly used workbooks to check what equipment and instruments they needed to prepare for surgeries, and how convenient it was to store these workbooks on a portable device instead of searching for paper files, books and carrying paper around.

Secondly, the affordance of *visualization* of their work emerged. For example, OR assistants used iPods as a camera if surgeons asked them to take a picture of something medically interesting discovered during a surgery. They also used the iPod's camera for taking pictures of equipment if it broke when they needed to communicate the problem to technicians.

A third affordance is *connectivity*. All the OR assistants started using email for work purposes and email use has dramatically increased after the introduction of the iPods. This additional and flexible functionality of the technology contributed to the satisfaction with the device, and OR assistants described iPods as very useful for their work. The enthusiasm about the iPods was widely shared by OR nurses.

After the initial listing of all this work-related functionality and upon further probing questions, assistants described a number of examples of non-work related affordances as well. During interviews assistants said that they very often used their devices for private email, checking Facebook, chatting, and messaging friends and family. Together with other non-work related functions such as surfing online, listening to music, playing games, using personal mobile banking functions, taking personal pictures and sharing these with friends and colleagues, this affordance can be described as *entertainment* – helping circulating nurses to overcome the "micro-boredom" (MacCormick et al. 2012) that characterized their long periods of waiting when nothing happened that required their involvement with the surgical team.

The affordances of the iPod: the onlooker's perspective

Because scrub nurses are sterile during the surgery they are quite restricted in their movements and basically stand in one place during the whole procedure. These restrictions mean that they cannot easily come up to the circulating nurses to check what they are doing on their devices or stretch out to look at the device's screen. We found that from the perspective of onlookers, the main affordance inferred was *entertainment* – in other words, onlookers talked about their counterparts' use of the iPods primarily in terms of the non-work related affordances. Onlookers, however, did not frame this affordance in terms of overcoming boredom, but in terms of *distraction* and *disturbance* of the implicit coordination required by their interactive work practices.

These onlookers' interpretations were mainly based on users' *body behavior* and their *own experience* as a user. Users' body behavior was described by onlookers in terms of circulating nurse's body postures (shoulders bent, sitting on the chair peeking on the device), hand movements (typing, scrolling), face expressions (smiling, peeking, laughing), their proximity and position in the room (sitting close to or far away from scrub nurse). Consider this description, for example:

> "Some of my colleagues are going to sit there [shows that they will be behind her back] and are going to read [shows absorbed posture in the iPod] and they are not with the team. (Interviewee 4)

Own experience also helped to interpret enacted affordances, as nurses constantly switched roles of user (when circulating) and non-user (when scrubbed). Interestingly, however, as onlookers, scrub mainly inferred the non-work related affordances, previously described as entertainment. The work-related affordances of information accessibility, visualization and connectivity were hardly mentioned from the

onlookers' point of view, or as a minor part of the users' activities. Consider, for example, how this nurse replies to the question "what do you think they are doing on the iPod?":

> "Interviewee: They are checking their Facebook.
> Interviewer: Do you think that they are checking their Facebook?
> Interviewee: Oh, I know it. I don't think – I know! [laughs]. <*how do you know it?*> Well, because everybody here on the floor has their Facebook and you can't be constantly checking protocols or things for work – that's done in 5 minutes. You can't do that the whole, the entire day. So they *have* to be doing personal things. Facebook or emailing, or texting, what'sapping, you know" (Interviewee 28)

The majority of interviewees described their counterparts enacting this affordance in negative terms: instead of an understandable way to overcome boredom (from the user perspective), escapism was described in terms of distraction, and disturbance of the implicit coordination required by their interactive work practice (from the onlooker perspective):

> "Some colleagues are SO into their phone, or their iPod! And they don't listen to what's happening around, and then it's annoying! Because sometimes as a scrub nurse you need it quickly, and it's really annoying, if the circulating nurse doesn't listen. You have to say "Hello! [shows that she is waiving hands to attract attention] I need you!" [calling out loud] And that's really annoying! And that happens more often now!" (Interviewee 38)

At the same time, consider, for example, how the same nurse describes her own iPod use in the interactive work practice:

> "Interviewer: Do you have to be always watching what is happening?
> Interviewee: Yeah, you have to. And I always… yeah… I… well, not always… but I watch what they do, sometimes I check my iPod, my email….and [whispering, to the side] doing a little game… [laughs]… if it takes a long time" (Interviewee 38)

Contrasting the opinions that nurses expressed when describing their *own* use of iPods and when talking about the use of *others* helped to reveal the role conflict between user and non-user, even when these roles were performed by the same person at different times. When speaking from the perspective of scrub nurses, they almost unanimously expressed annoyance with *others* being too involved with their iPods, their enactment of the entertainment affordance leading to their counterparts being distracted, and disturbing the implicit coordination in their interactive work practice.

Reciprocal inferences and the influence of onlookers

In the final step of the data analysis we aimed to get insight into if and how the onlookers' interpretations influenced the affordances-in-use. Ultimately, this answers the question what the influence of onlookers is on the use of mobile devices, and the way these devices impact work practices. We coded observation and interview data to capture instances that indicated any possible consequences of onlookers' inferences for user behavior. As a result of this coding, we identified that users experienced tensions about their iPod used that were reflected in their user behaviors. By "tensions" we refer to users' uneasiness originating from their iPod use because of contradictions to the established work norms. Due to social desirability bias, these tensions could not be easily identified in the interview accounts: it would be unlikely that nurses admit they often don't pay enough attention to surgical procedures or play games in the workplace. This is why we mostly relied on field notes, searching for cases and actions reflecting these tensions. Also, interviewing respondents, we encouraged them to speak about these by providing examples of personal tensions experienced with the mobile device. Finally, we made use of onlookers' interpretations to identify user's tensions: if they described circulating nurses' moves as guilty or exhibiting hiding manner – as seen when someone is checking the phone under the table – we inferred that such guilty looks were symptomatic of tensions experienced by user.

The negative inferences about the iPod use for entertainment contributed to the feelings of uneasiness and *guilt* about their iPod use. This was apparent during observations, in which we saw that one of the common manners of using mobile device was taking it out from the pocket with one hand and quickly glancing at it holding it secretly down, at the level of one's hip. Another manner of checking the iPod was to reach for it while sitting behind the instrument table, and look at it under the table, which shielded the

view from onlookers. The swiftness and "hiding" character of these movements and glances reveal that circulating nurses wanted to appear focused on the operation, as their partners expect them to be.

Also, when describing how others are using the devices, nurses often described similar secret manners of use, which together with observations indicated that users were willing to hide their use from onlookers and felt guilty of not paying attention:

> "Interviewee: Yeah, they do take it out, and they watch it sometimes, I know, because they are doing this – [shows that they do it secretly and raising eyes to check if she is following their actions]. So I know they do, but not that often. Yeah… with a guilty face. And I know that they are doing Facebook.
> Interviewer: How do you know that?
> Interviewee: By the looks. And sometimes I ask – if I am in the preparation room, when we are preparing the next operation – I say – "ah, you were going to Facebook, right?" and they say "oh, yeah, I did, I did" [in a confessing tone, apologetically]" (Interviewee 7)

> "Sometimes they do it like that - just for a moment [shows a quick movement of reaching for the iPod, throwing a quick glance, in a hiding way and putting it back]. But they understand. I don't have to say – "Hey, don't watch that thing anymore", I don't do that. And they know, they feel it, because they know it's not allowed, to look a lot at their iPod is not good, they know it" (Interviewee 13)

Users also became *defensive*, explaining that their use of the iPod was not only aimed at enactment of the entertainment affordance, but that this was combined with the work-related affordance of information accessibility. This was especially the case at the beginning of interviews, where nurses mostly appeared willing to maintain the image that they themselves were rarely using the iPod for entertainment. At the end of the interviews, however, when the nurses realized that the interviewer was familiar with their practices in detail, they mostly opened up and described how and when they used their devices for entertainment. The way they "confessed" this was indicative of the contradiction of their use to the established work norms and their willingness to justify this socially undesirable behavior. Consider how these nurses describe how they use their iPods:

> "Mostly email…. Sometimes WhatsApp [laughs] – I have to admit – but it's anonymous, right? [laughs]. No, sometimes, when you sit all the time, and you check your iPod and "Oh, I have friends online" and you reply. Something like that. But I think when you have a job in the office, you also do that. So why should not we be able to do that? That's a little thing I think. And sometimes I check the weather, if it's going to rain when I go home. And sometimes the news, if something happened" (Interviewee 35)

Still, such "confessions" were typically combined with statements emphasizing that the iPods provided multiple affordances – both entertainment and work-related ones - which were both enacted:

> "Yeah, it's easy to think that someone is on the internet or something like that, but most of the time we are also reading the procedures. Yeah, and doing games, yeah. Different things. And it's not right that you always conclude "Oh, he is on the internet!" [in a complaining tone]. You can also read on the internet what you see about the illness or something like that" (Interviewee 4)

Interestingly, a new affordance of the iPod manifests itself in these accounts: the affordance of *invisibility*. The small size of the device and its screen, combined with the fact that the circulating nurse was physically in another area (the non-sterile one) enabled the user to hide their actual use from the onlooker.

These accounts demonstrate that users were very much conscious of onlookers' interpretations. Thus, just as onlookers inferred what iPod affordances were enacted by circulating nurses, circulating nurses in turn inferred what onlookers might be thinking about their iPod use. This created a mechanism of reciprocal inference – onlookers infer the function-in-use, while users infer the interpretations of onlookers. This reciprocal inference is made possible by the nurses' knowledge of both roles, and plays a role in their interactive work practice. These reciprocal inferences explain that the iPod's affordances in the context of the OR practice were shaped by (1) users interacting with the device, (2) onlookers making inferences about this use, and (3) users making inferences about the onlookers' perceptions of their use. In other words, the action possibilities of the iPods depended as much on what users thought they could do on the iPod during surgery, as by what their partners perceived as enacted.

As a result of this reciprocal inference, the iPods' affordances were enacted in the following way.

Circulating nurses wanted to appear as always being attentive to the procedure and being able to integrate their desire to use mobile device with the implicit coordination with the scrub nurse. To that end, they mostly employed their body behavior and kept using the iPod and at the same time managed their interaction with the scrub nurse. Specifically, they did that by sitting close on a chair, using their iPod secretly and checking it at moments, when the scrub could not visually see them. In this way, they utilized both the small size of iPod and their body behavior to adjust their use to the onlooker's interpretations. In terms of function, they continued using iPods for both work-related and non-work related things, such as chatting and games. Returning back to the example of Julia who checked her iPod every 5 minutes while circulating during plastic surgery, consider this description of how she was doing it:

> "Julia is reaching for her phone at regular intervals of 5 minutes and types in, which looks like chatting online or texting. She does that while sitting on a chair next to the instrument table, and sometimes when standing very close to the team from the other side. Her body is always facing the surgery procedure, only during the times when with the device – head is down. When she sat – I could not see if she actually had a phone – it was on her knees and shielded by the table. It looked like Natalia (scrub) never saw her using the mobile device – since Natalia was most of the time facing surgery and Julie was sitting behind her and her texting was invisible behind the table".

In summary, the circulating nurses (users) used the iPods in their individual work practices, enacting both work-related (accessibility of information, visualization, connectivity) and non-work related (entertainment) affordances. This had a positive impact on this individual work practice, both in terms of work support and overcoming boredom. In the interactive work practice with the scrubs, however, the onlookers' interpretations played a prominent role in adjusting enactment of these affordances. The onlookers primarily viewed the use of the iPod as an entertainment and thus a negative influence on the interactive work practice in terms of distraction and disturbance of the implicit coordination between scrub and circulating nurse. This negative perception, in turn, influenced how users further enacted and perceived the iPod's affordances: they felt guilty and defensive, and hid their use from the onlookers by enacting the affordance of invisibility. This resulting behavior further negatively influenced the interactive work process, as circulating nurses isolated themselves even more from their surroundings, negatively affecting their ability to anticipate and dynamically adjust to their counterparts' needs.

Discussion and conclusion

Our findings indicate that the impact of iPod use on the interactive work practice involving both scrub and circulating nurse was primarily negative. In particular, responding to the onlookers' interpretations of iPod use as a distracting and disturbing behavior, users enacted the affordances in ways that further negatively affected the implicit coordination. As Rico et al. (2008) explain, implicit coordination relies on the existence of an emergent *team situation model*, a dynamic, context-specific shared understanding of the current situation that is developed moment-by-moment. Our findings indicate that the reciprocal inferences about the iPod use, led to users being less *engaged* with the interactive work practice (MacCormick et al. 2012), which hampers the development of such a team situation model and thus negatively influences the implicit coordination required for the interactive work practice.

The recognition of the onlooker's role as an actor influencing perceptions and enactment of affordances through the *reciprocal inference* mechanism provides relevant contributions to both the literature on technology use in general, and to the affordances literature in particular.

First, as discussed in our theoretical background, the literature on technology use tends to have a blind spot for the social context in which users interact with technologies. The focus is strongly on the actor-artifact interaction, which is perfectly logical but does underplay the role of the "others" who are often present when this interaction takes place. The onlooker perspective emphasizes that users do not interact with a technology in a vacuum, which is especially relevant for ubiquitous and invasive mobile devices, which tend to challenge boundaries between the public and the private (Lever and Katz 2007) and often directly influence the interaction with "others" in the users' physical environment (Gergen 2002).

The relevance of this onlooker perspective becomes especially clear when we relate it to the affordances literature. Our study responds to calls to "socialize affordances" (Costall 1995; Faraj and Azad 2012), to more explicitly address the role of the social context in the shaping and enactment of affordances. Much previous empirical research has employed the concept of affordances in ways that did not go beyond

describing technology's functional features, and showing how users appropriated these features (Goh et al. 2011). While these studies attempt to illustrate how affordances are activated or imbricated with human agency (Leonardi 2011), they do not include the full range of relevant relations, actions and perceptions of these actions by surrounding context, and thus fail to uncover affordances' relativity to action in context. The identification of the process of *reciprocal inference* sheds light on how onlookers play an important role in shaping users' perceptions and enactment of affordances, and how such affordances are related to the impact these devices have on interactive work practices.

Our findings also contribute to the sociomateriality discourse. In line with the conceptual framework of sociomateriality, our study shows how essentially a social dimension – interaction between a scrub nurses and circulating nurse in their interactive work practice - contributes to the ways in which technology's materiality is used. Moreover, our analysis has revealed the importance of the material dimension in forming users' and onlookers' interpretations – the small physical shape of an mobile device afforded invisibility of user activity, while the availability of various software apps on the iPod influenced both the affordances enacted by users and the onlookers' perceptions of these affordances. Materiality was also apparent in the form of user body behavior – posture, movements, position in relation to the onlooker, which also constituted a basis for onlooker interpretations. Our study, however, departs from sociomateriality's central thesis of "constitutive entanglement" of the social and the material (Barad 2007; Orlikowski 2007). While the user absorbed in the iPod might appear as a representation of such a constitutive entanglement, this is not the case for the relation between the onlooker and the iPod, who had no direct relationship at the moment of use. This reminds us that except for the relations between user and technology, there exist other relationships between actors which are "external" to the interaction between user and object (Faulkner and Runde 2013). Yet, such an external relationship, as our case showed, can exert influence on how the object is used, via reciprocal inference. This influence could only be revealed by abandoning user-centric assumptions of technology in use and recognizing the physical presence of other actors, who are not "entangled" with the technology.

Finally, we make a contribution to current research on mobile technology. Previous studies equated mobile technology with some particular function that was inscribed on the devices, such as email (Mazmanian et al. 2013) or telephony (Hislop and Axtell 2011; Wajcman and Rose 2011). Modern mobile devices (smartphones, tablets, netbooks), however, provide multiple functions and also come in different physical shapes (smartphones, tablets, netbooks). By looking into the physical and digital aspects of iPods, we illustrated what affordances were provided to users by the iPod's physical form (invisibility of use) and its digital functions (accessibility of information, visualization, connectivity, entertainment). Including these different functions of the device, and the different perspectives on these functions, provided a more complete analysis of the impact of the device on work practices than if we had only concentrated on the users' perception of only one function.

Our study has two important limitations. One is that we only studied the use of the device during a limited timeframe, that is, during a year. Consequently, we cannot tell if the identified affordances and their enactment were temporary or changed over time. For a more dynamic perspective on the development of technological identities, future research needs to use process analysis using a longitudinal approach. At the same time, we believe that the richness of ethnographic detail from such an extraordinary and vitally important setting compensates for the lack of process perspective by providing deep insight into OR work practices (which are not widely publicly known) and the impacts of mobile devices on these practices.

Another limitation to this study is its generalizability. While generalizing to other fields of technology use was not our intention, it should be noted that our findings are predominantly aimed to trigger future research in the field of technology in the workplace. Future studies should investigate other settings where mobile technologies are introduced for different reasons and with other functionalities. Evidence from other sectors and fields, reporting how mobile technology is perceived by both users and onlookers and further used in practice is warranted in order to understand wider implications of mobile technology for the nature of work and professions.

Notwithstanding the limitations, we believe that our study provides a foundation for understanding many current phenomena associated with the use of mobile technology in contemporary life. In fact, given the fast development of mobile devices, it might be easily anticipated that many previously static technologies (such as ERP, for example) will become mobile and thus their use could be better understood when incorporating the onlookers' perspective. In addition, our study sets the stage for analysis of newly

developed mobile technologies, such as Google Glass or Augmented Reality Glasses, which are even more integrated in physical settings and thus require understanding of the onlookers' role in how these technologies will be used. So far, however, the implications of our study primarily concern behavior of users of mobile devices, as it is often associated with blurring boundaries between public and private, distraction and disturbance, guilty feelings, hypocritical behavior (pretending to be doing work-related things while chatting) and involves frequent switching between being a user and witnessing use of others.

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