

THE USER-CENTERED NATURE OF AWARENESS CREATION IN COMPUTER-MEDIATED COMMUNICATION

Completed Research Paper

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Abstract

In face-to-face contexts, information about the activities, context or emotions of others is typically available and often taken for granted. In computer-mediated communication (CMC) contexts, this awareness information is not readily available and thus needs to be actively signaled by users or technology or otherwise conveyed as byproduct of the ongoing interaction. We present a theory of the dynamic creation of awareness via computer-mediated communication illustrated by a metaphor of pools fed from streams of interaction. Pools of awareness are held within users and gradually fill via signals from others. Users need different pools to be fed and draw from the streams of interaction to feed their pools and reciprocally place information in the streams to feed the pools of others. In addition, pools drain and must be replenished when a new CMC encounter begins. Awareness is thus created actively or as byproduct of social communicative practice, but is not an instant product of technology. We formulate theoretical propositions and discuss implications of our proposed theory for CMC researchers and practitioners.

Keywords: awareness, computer-mediated communication, presence

Introduction

People increasingly work and live in distributed contexts, where they and those with whom they interact do not share a common physical environment (Leinonen et al., 2005; Mark, 2002). Interacting in a distributed context necessitates the use of computer-mediated communication (CMC), meaning one cannot as easily obtain much of the information about others that is readily available in face-to-face contexts, such as information about activities, physical context, emotions, etc. of others (Scupelli et al., 2005; Gutwin and Greenberg, 2002). Lack of information about others and the resulting uncertainty is believed to create the coordination problems typically seen in distributed work, such as inter-group conflicts (Rennecker, 2005) and adverse reactions to external events (Tangirala and Alge, 2006).

Coordination can be difficult when information about others' actions and personal and individuating information must be actively sought (Tangirala and Alge, 2006). One prominent framework suggests that technology designers can fill these needs by providing information about: who is present in the mediated space, where is their attention focused in the mediated space, and what task are they accomplishing in the mediated space (Gutwin and Greenberg, 2002). Another framework goes further, suggesting that technological tools should also provide information that defines the boundaries of a group within the mediated space (i.e., group awareness), convey others' interests, attitudes, and personal feelings (i.e., social awareness), in addition to information about the mediated space and the objects in it (Gross et al., 2005). Such technology tools in distributed contexts have been experimentally shown to increase conformity (Haines and Mann, 2011) and motivation (Shepherd et al., 1996) over those that did not have such tools.

These frameworks and experimental results suggest that there are limitations to CMC encounters that can be overcome by providing technological tools. Such tools might provide information about the presence (Lee, 2004), identity (Cooper and Haines, 2008), and activities (Dourish and Bellotti, 1992) of others. However, this technology-centric approach runs contrary to the notion that with the "passage of sufficient time and messages exchanged," mediated communication will be experienced in much the same way as face-to-face communication (Walther, 1992). In this paper, we argue that simply looking at how much information can be transmitted verbally or nonverbally in a given context understates what is a qualitatively different situation to the interactants. When interacting with someone that is not bodily present, it appears that one will attempt to cognitively and/or verbally compensate for the missing other (e.g., Emberson et al., 2010; Lee, 2004).

The goal of this paper is to develop a new conceptualization of the nature of awareness, which we define as information about others that is used to facilitate coordinated behavior in a social setting. Our notion of awareness is consistent with prior conceptualizations, but we wish to clearly differentiate this paper from prior research and frameworks that sought to explicate the fundamental awareness needs in mediated encounters (e.g., social presence, identity awareness, activity awareness, etc.). For example, Dourish and Bellotti define awareness as "an understanding of the activities of others, which provides a context for your own activity" (1992, p. 107). While we recognize that awareness of the activities of others might be a critical need for a particular user in an encounter, other users in different contexts may have other awareness needs, such as building trust (Jarvenpaa et al., 1998). Thus, we note here that we conceive of awareness as potentially consisting of multiple dimensions, each of which represents a need that might be felt and met separately.

This is a conceptual, explorative and theory-building paper. Against the above backdrop we will engage with the construct of awareness in computer-mediated communication. While a large body of research has investigated awareness, such as different types of awareness, technologies for awareness creation, and the positive effects of awareness for improving coordination via CMC, there is a distinct lack of conceptual understanding of the construct itself and how awareness arises (Schmidt 2002). Therefore, we offer a set of theoretical propositions in reply to the following two research questions: 1) What are the characteristics of awareness as a construct? 2) How does awareness arise in CMC and what is the role of technology in awareness creation?

Drawing on existing literature, a hypothetical CMC scenario (introduced below), and examples of everyday communication behavior, we will expose awareness as a dynamic construct, created through user actions, enabled and shaped by technology. The proposed dynamic awareness theory will contribute to a

better understanding of the anatomy of awareness as a construct and its creation, thereby providing a basis to reignite research on this unquestionably important topic. In doing so, we offer a distinct Information Systems perspective, which goes beyond the tool-centric understanding that dominates the orthodox view in neighboring disciplines.

The paper proceeds as follows. In the next section we will motivate our study and position our research. For doing so, we offer a thought experiment in the form of a hypothetical CMC encounter. Thereafter, we will expose the current dominant view of awareness in the literature, and argue for an action-centered view. Sections four and five are the core of the paper, offering propositions regarding awareness as a construct and awareness creation as a product of user actions. We then discuss our findings to derive implications for researchers and tool designers.

Motivation and Paper Overview

Our paper rests on the observation that awareness in mediated communication is not strictly analogous to face-to-face communication, but has different, unique needs that arise from the specific characteristics of a mediated encounter. To illustrate this point, we offer a brief scenario outlining a hypothetical communication encounter in an online chat environment

A hypothetical CMC encounter

Imagine a situation in which an experimenter leads a person to a computer terminal. No other people are present, but on the computer a chat program is running (Figure 1). There is nothing on the screen other than the window, and only a flashing cursor to indicate that any activity is taking place. What will the person do? There is no indication that another person or persons is at “the other end” and will respond to messages, only the implicit suggestion that something might happen if the person enters something, which comes from a general familiarity with “experimenters,” “computer terminals,” and “chat programs.”

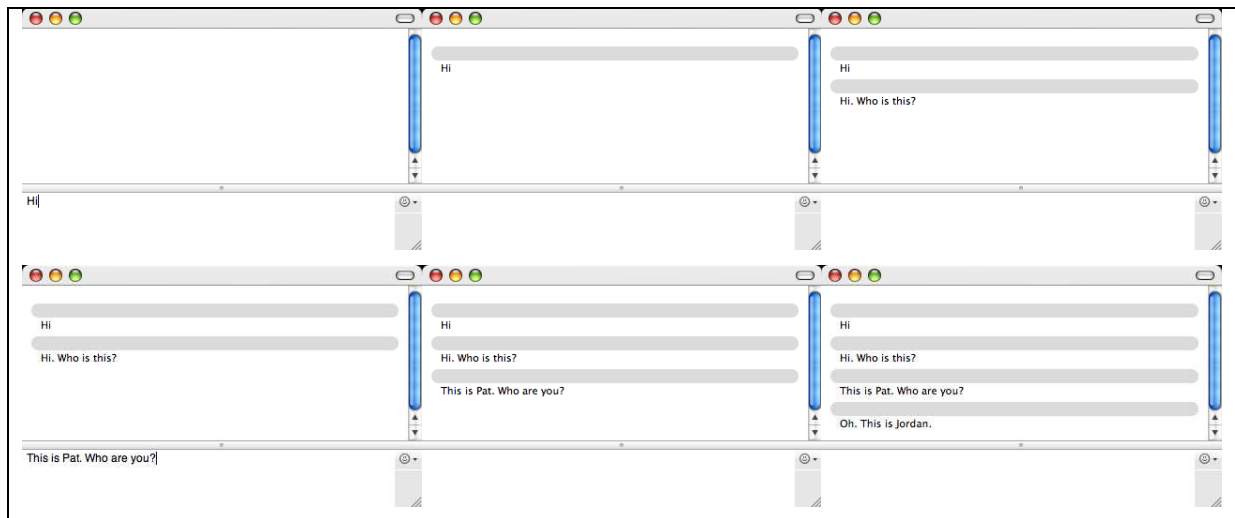


Figure 1. Chat illustrating the hypothetical CMC encounter

Once seated, the person types “Hi” and presses enter. His/her “Hi” then appears on the upper part of the chat screen. A short time later, “Hi. Who is this?” also appears on the upper part of the screen. The person types, “This is Pat. Who are you?” and presses enter. A short time later, “Oh, this is Jordan” appears. From here, a conversation can unfold: it might concern a recent party that each of them attended, a discussion of current political issues, or anything else that they might wish to talk about. What enabled this conversation to occur?

We acknowledge that the situation described in this hypothetical encounter is a simplification in that there were relatively few assumptions that could be made by the person up front, but we believe that it serves well as a first step in illustrating the basic mechanisms and underlying activities by which awareness is created in mediated contexts. Initially, the person has little sense that another will receive and respond to his/her messages, and must rely on internally constructed projections of what will happen based on his/her prior experiences with similar computer programs and situations. After the first entry, he/she can see that the computer system is at least processing his/her messages, but still must assume that there is the potential for another person to receive and respond to his/her messages. After the first reply is received, he/she can only be sure that at least one other is receiving their message. Eventually, he/she learns the name of the person with whom he/she is communicating. At this point, the person may recognize the other as a friend or acquaintance, and what was formerly an unfamiliar and/or uncomfortable situation may become a more “natural” interaction. Even if the other is a stranger, the interaction will likely become more natural as the person learns aspects of the situation of the other, more about the likes/dislikes of the other, etc.

As an introductory narrative, this hypothetical CMC encounter provides an illustration of our dynamic view of awareness creation, in which awareness is conceived of as building gradually within users over the course of an encounter. In CMC encounters, interactants seek and provide information according to their needs for facilitating the interaction (cf., Berger and Calabrese, 1975). These information needs are filled by *awareness*, and the process whereby these needs are sought and met in distributed contexts is both facilitated and limited by technology. We argue that a limited, technology-centric view must be abandoned in favor of a action-based, user-centered understanding of awareness creation. As such, we contribute to a better understanding of the construct itself and the mechanisms of its creation by applying our dynamic notion and contextualized understanding. We begin by exposing the current understanding of awareness in the literature.

Awareness needs in computer-mediated communication

The principal difference between face-to-face communication and mediated communication is the lack of embodiment in a shared physical context. In face-to-face communication contexts, there is a sense of continual observation: one’s body is or can be observed at any time during an encounter. Our familiarity with a situation enables us to pick up the relevant signals effortlessly. The activities performed by the interactants form their vivid social present (Schütz, 1945, p. 536-537). In the social present, actions are assumed to be directed at an object or goal, meaning interactants make sense of already performed acts (i.e., the past) and current actions as leading to a state of affairs to be brought about by the acting (Schütz, 1945, p. 538).

When interacting via mediated communication, one is physically separated from others: one does not directly observe others; one observes the results of another’s actions, which consist only of what has been captured and presented by the mediating technology. For example, when engaged in a real-time chat, one does not directly observe another as he/she presses keys on the keyboard and/or moves and clicks the mouse, one sees only the results of the key presses and mouse clicks, presented in a way that is coded into the mediating technology. This lack of direct observation has wide implications for the expression of oneself in a social world. Media richness theorists recognized that a subset of one’s actions were being presented to others, and noted the potential for others to perceive of one as being “less present” (Short et al., 1976), and that there was an overall paucity of information communicated when using textual mediated communication (Walther, 1992). However, this lack of presence and paucity of information apparently does not hinder users of mediated communication from achieving a variety of social goals (Kock, 2001; Markus, 1994; Dennis and Kinney, 1998; Rice, 1993). So how do users adapt to the unique circumstances in mediated encounters?

It appears that people in mediated interaction have an inherent need to construct an awareness of the embodiment of the other. Depending on their needs, this awareness will have a number of dimensions, which might include the other’s surroundings, their appearance, their actions, etc. From our perspective, the physical disconnection from others is the most salient differentiating aspect of mediated communication and the primary reason for the need to create actively the awareness of others in a distributed context. Without the physical presence of the other, one cannot rely on the embodied, effortless coping with the shared situation, but rather has to attempt to find other means to construct (and

reconstruct) an understanding of the other and their situation (cf., Lee, 2004). Said more broadly, interactants via mediated communication need to (learn to) construct the social past, intended future, and living present of him/herself and others using the traces of their physical activities that are presented to them by the mediating technology.

Overview of awareness research and positioning of our study

Awareness has been defined as “an understanding of the activities of others, which provides a context for your own activity” (Dourish and Bellotti, 1992, p. 107); it “involves knowing who is ‘around’, what activities are occurring, who is talking with whom; it provides a view of one another in the daily work environments” (Dourish and Bly, 1992, p. 541). A general lack of awareness has been recognized as a problem in communication encounters and distributed work (Rennecker, 2005) and a large body of research has investigated various aspects of awareness creation. However, the vast majority of works have originated from fields that are close to computer science and software design, hence taking a technology-centered approach to awareness and awareness creation. We argue for a more practice and user-centered understanding of awareness. However, we are by no means the first ones to recognize the need to treat awareness as arising from user practices (e.g. Schmidt, 2001, Heath et al., 2002). Our main contribution in this conceptual paper will be to offer a clear conceptualization of awareness as a construct and the mechanism in which awareness arises from technology-mediated activity. For doing so we will propose theoretical propositions, which will expose the nature of awareness as a construct and the mechanisms of awareness creation (and the role of technology therein).

Awareness is sometimes treated as a property of a technology (e.g. Koch, 2005), sometimes referred to in terms of the user behavior creating awareness (e.g. Heath et al., 2002), sometimes in terms of certain awareness needs in communication encounters (e.g. Ljungstrand and af Segerstad, 2000), or portrayed in terms of its (positive) effects in enabling communication and group coordination (e.g. Boyer et al., 1998). Indeed, some have decried the lack of conceptual clarity noting that the term awareness “is obviously found ambiguous and unsatisfactory” (Schmidt, 2002, p. 286).

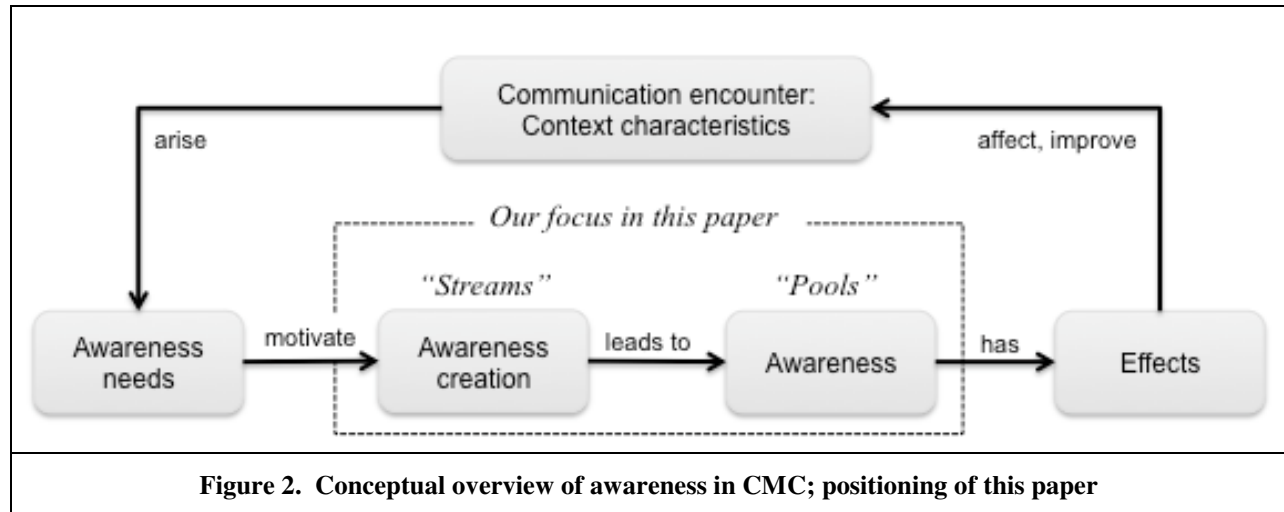
The first step towards better conceptual clarity is to separate awareness as a construct from the mechanisms of its creation on the one hand and from its effects in affecting the communication encounter on the other. Therefore, we offer the model depicted in figure 2. We have argued that CMC encounters have unique awareness needs when compared with face-to-face encounters. Our hypothetical encounter above serves to illustrate that individual awareness needs motivate the creation of awareness. Awareness in turn is commonly associated with certain (most often positive) effects, such as improved coordination, which in turn will affect, enable or improve the interactants ability to achieve the intended future of the CMC encounter (e.g., a distributed work task). While research in the CMC field has generally focused on different objects and types of awareness (e.g., Gross et al., 2005), discussed the need for and implications of awareness (Leinonen et al., 2005; Mark, 2002; Rennecker, 2005), and explored to a great extent the design of technologies to produce awareness (Dourish and Bly, 1992; Gross et al., 2005; Gutwin and Greenberg, 2002), surprisingly little is known about the nature of awareness as a construct and how it arises in CMC encounters. Therefore, this paper focuses on two research questions:

1. What are the characteristics of awareness as a construct?
2. How does awareness arise in CMC and what is the role of technology in awareness creation?

In the following we will provide an overview of existing awareness research and argue for a more action-centered view of awareness creation. The following two sections are the core of our paper. First we will offer a set of four propositions capturing our understanding of awareness as a construct. Second, we will capture the mechanisms of technology-enabled awareness creation in another set of three propositions. In doing so, we will introduce a metaphor for illustrating our view of awareness as conceived of as pools, filled by streams of information, carried and facilitated by technology.

In our analysis, we will draw on existing literature, analyze the above hypothetical CMC encounter, and use well-known examples of media use and every-day communication behavior in CMC encounters to illustrate our line of reasoning. We want to stress again that our paper is purely conceptual, explorative and theory-developing. In doing so, we offer our theory of dynamic awareness creation as a theory for

explaining, which exposes certain mechanisms and explains how things are (Gregor, 2006). We see this as a necessary step towards deriving testable, theoretical relationships between constructs in future studies.



Awareness in the Literature

For quite some time, researchers have been interested in the concept of awareness in mediated contexts and its creation through the use of technology. While early studies in the field investigated awareness in the context of shared social practices in collocated, face-to-face workplaces such as air traffic control (Harper et al., 1989) or subway traffic control rooms (Heath and Luff, 1992), the research focus in the awareness domain shifted to a more technology-driven viewpoint.

A technology-centric notion of awareness creation

From a technology-centric perspective, systems create certain types of awareness by means of specific technological features (e.g., Gutwin et al., 1996; Koch, 2005). This notion is implicit in many publications: specialized awareness applications (e.g. Markopoulos et al., 2009) are developed to address awareness problems (Boyer et al., 1998; Ljungstrand and af Segerstad, 2000); applications have certain awareness functions or features (Borning and Travers, 1991; Scupelli et al., 2005) that gather and provide awareness information (Jang et al., 2000) in order to promote or support awareness in collaborative work (Rennecker, 2005; Gutwin and Greenberg, 1996).

In the technology design process, different types of awareness are distinguished according to the reference object to which the awareness is directed - for example, task-related awareness is in relation to the activities of others, or social awareness is in relation to emotional states of others (Gross et al., 2005; Robertson, 2002). Mediated technology systems generally aim at creating virtual environments that simulate the real world and its ways of creating awareness through inscription in technology (e.g., Borning and Travers, 1991; Boyer et al., 1998; Gutwin and Greenberg, 1996; Gross et al., 2005). The predominant awareness frameworks thus propose that collaboration will be enhanced when systems gather and communicate awareness information about others in a shared workspace, and provide designers with a list of suggested awareness features that should be incorporated into such systems (Gross et al., 2005; Gutwin and Greenberg, 2002).

By thinking of awareness as derived from technology features, there is a danger of viewing it as something that can be created by way of design and produced instantly by way of technology application. For example, in the context of Instant Messaging (IM), researchers have stressed the importance of what is called the presence awareness capability (Cameron and Webster, 2005). This feature typically functions such that an icon signals the status of a user, showing whether the user is online (Carmona, 2007); in essence, the application has registered with the IM server (Luo and Liao, 2008). Awareness of one's presence is thus believed to be created instantly via IM by gathering, transporting and revealing the status information to others (i.e., only delayed because of the time required to start the application and connect

to the status server) – leading to the suggestion that such tools “support awareness of presence in real-time” (Ljungstrand and af Segerstad, 2000).

Towards a user-centered understanding of awareness creation

While the technology-centric view still dominates in the literature, with awareness being treated largely as an outcome of systems design, some authors have argued for a more practice-oriented, embedded view of awareness creation (Heath et al., 2002, Riemer et al., 2007, Schmidt, 2002). Riemer et al. (2007) found a surprising variety in both the types of awareness and the ways in which awareness was created across five mediated communication contexts in which the same IT artifact was used. They argued that awareness, as created in a social context, goes “way beyond what can be expected from the tool and its ‘built in’ awareness capabilities.” (Riemer et al., 2007, p. 1). Other scholars have similarly argued that awareness is a learned, embodied, skillful action, which is why awareness is neither the “product of passively acquired ‘information’” (Schmidt, 2002, 292), nor is it a property of technology (Robertson, 2002).

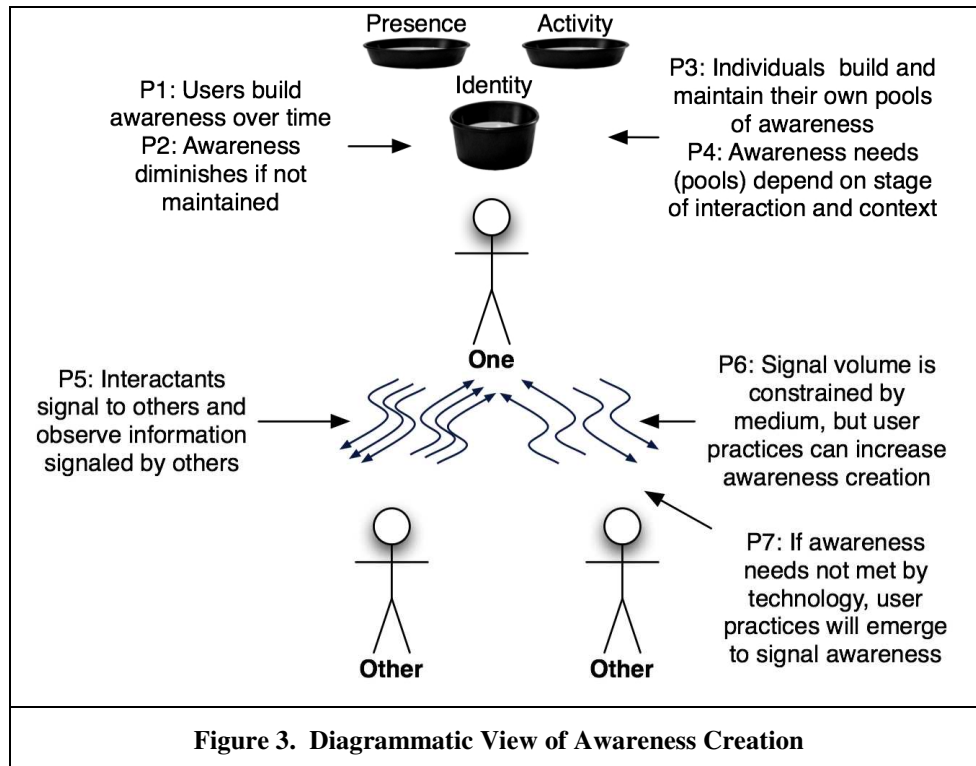
In line with this, we suggest that awareness is not something that is created by technology; rather, users gradually build awareness as they observe and interpret signals from others (cf., Schütz, 1945). Indeed, observing the status of a technology feature does not necessarily provide unambiguous awareness to a user. At the extreme (but likely quite common in practice), the awareness information that is provided by a mediating technology may be interpreted as being false or incomplete, requiring additional signals to be realized as awareness. For example, although another’s IM icon currently indicates “online:” (1) the person may have stepped away from their computer without updating their status, (2) someone else might be using that person’s computer, or (3) the person might be working on another task and not actually available for interaction. Furthermore, IM applications typically allow one to indicate “away” or even “offline” while connected, meaning that one can be physically present and capable of communicating, but suppress the indication of it. When faced with such uncertainty, IM users often adopt practices such as changing their status message or screen name to indicate whether they are available for interaction (e.g., “really am busy, only msg me in emergency,” or “reading at my desk/disregard (Away) status” [Smale and Greenberg, 2005, p. 6]) or sending a preliminary message that asks whether another is actually available (e.g., “Time to chat?”).

Furthermore, users have been shown to adapt their communication and increase awareness within the bounds of technical limitations by shaping their behavior (Walther, 1992; Carlson and Zmud, 1999; Riemer et al., 2007), and users can also limit what information is “passively” captured by technology by altering their behavior or environment. For example, an experienced video conferencing user may take great pains to stage the area behind and around them to ensure that nothing undesirable enters the field of view, and an at-home technical support operator might take precautions to prevent audible interruptions from children or other environmental noise that might disrupt their interactions. These manipulations of what is captured by the mediating technology are among the most overt examples of how users adapt their communicative actions when using mediated communication. Thus, awareness creation in CMC can only be sufficiently understood by taking a richer perspective of the communicating individuals, their contextual needs, and communicative actions. Technology acts as an important and necessary (but not sufficient) mediating ingredient.

Characteristics of Awareness as a Construct

In our hypothetical encounter outlined earlier, the person seated at the computer had only a minimal feeling that someone would receive and respond to his/her messages because the other was not physically present and could not be directly observed. However, such needs essentially recur in every mediated communication encounter: before communicating, one must feel that another might receive and respond. When a response is received, one is only sure that another responded to the first message; over time, one will begin to feel that the other will remain present and not unexpectedly stop responding. This feeling can continue to heighten with additional message exchanges; meaning one’s awareness of another might extend to a profound understanding of the other person’s bodily context (e.g., the other is sitting at a desk in an office with an open window through which the other can hear a bird chirping). In a more traditional context, after one sends another the message “Time to chat?” via IM, one may get the response “Just a

sec.” With the response, one has confirmed that the other is indeed “present,” and may feel that the other will indeed respond to further messages. Thus, in distributed contexts, one’s awareness of others builds as one sends and receives information. In essence, we argue that awareness emerges like a pool starts filling with water (i.e., the first bit of information might be seen as the ‘first drop’ into the pool), and awareness builds as interaction proceeds (i.e., the awareness pool continues to fill), leading to more profound levels of awareness as additional information is received. The notion of a pool exemplifies how there can be relative levels of awareness over the course of an encounter. For example, one can initially have a sense that there are some people present in a chat room, then, after interacting for a time, one might have a sense that there are four different people and be able to differentiate among them, having further filled this particular pool of awareness. Figure 3 presents our view of awareness creation diagrammatically, with signals flowing between users, from which users can draw out awareness information and use it to fill their pools of awareness. Each of the propositions in the diagram is developed in detail below.



We again note that technology elements that are designed to convey awareness do not inevitably lead to unambiguous awareness (i.e., a *full* pool of awareness instantly). For example, a chat room’s list of present members does not necessarily ensure that all of the others are attending to the conversation, and although one might see that another is in front of his/her computer when video conferencing, one may not be completely sure that the other is attending to the conversation until he/she speaks. Thus, we suggest that awareness behaves like a pool that is filled gradually over the course of an encounter, and formulate our first proposition.

Proposition 1: Awareness developed via computer-mediated communication builds gradually; meaning different levels of awareness can exist at any point in time.

The reverse is also true – just as awareness builds gradually, it also decreases over time when signals from others stop or when one stops paying attention to them. For example, one can have a clear sense that there were four others present in a chat room at the time one left; however, awareness of who will be there ten minutes later is less certain, and one may not have a sense that anyone will be present at all after several hours. Similarly, while interacting via IM, one may learn that the other is in his/her bedroom at home. After a long pause, however, there may be some uncertainty about whether the other is still available to talk, causing one to ask “Are you still there?” Thus, we suggest that awareness must be

nurtured and replenished because it diminishes (i.e., evaporates from the pool) over time. We note that longer gaps may mean that a pool of awareness is nearly depleted: if another hasn't been online for several hours, one may no longer be sure if he/she is available to talk – if another hasn't been online for several weeks, one may wonder if he/she has moved and/or changed jobs. Similar effects occur via asynchronous communication such as e-mail or web forums – when others do not respond to one's messages or posts; one's pool of awareness diminishes and one may seek further information about their presence.

Proposition 2: Awareness developed via computer-mediated communication requires active maintenance because it diminishes over time.

Recognizing that every person might approach mediated communication differently, we further suggest that awareness is held within the interacting individuals. Although dyads and larger groups of individuals interacting via CMC are expected to have similar understandings of the meaning of certain messages, and therefore might build particular aspects of awareness at a similar rate, individual differences among members are expected to give rise to different levels of awareness within each group member. Thus, there is not a general store of awareness for a group, nor should technology produce information “for the group” (Gutwin and Greenberg, 2002, p. 434). Rather, each member of an interacting group has particular situational awareness needs. These are based on their own prior experiences and the degree to which they attend to and interpret the signals of others (Schütz, 1945).

The variability within group members is exemplified when a new person joins the mediated interaction of several others. Those that have been engaged in the interaction might be aware that three other people are participating in the conversation, while the new person may only have a sense that more than one other is present.

Proposition 3: Awareness is an individual-level construct; meaning that individuals maintain their own levels of awareness; awareness does not arise at the group or workspace level.

Awareness, as we have discussed it so far, is an accumulation of information about others. Individuals store and recall this information in order to guide their interaction with others (Mead, 1934). Here, we clarify that there can be multiple information stores about the others, which we have termed *aspects* of awareness. Particular aspects of awareness that are fundamental to some encounters have been studied in prior research, but we note here that individuals might accumulate different aspects of awareness depending on their needs in the context of an encounter. For example, an individual in an encounter can feel like others are “together” with them in the CMC environment and ready to respond (Biocca et al., 2003), while simultaneously feeling that they can positively identify the others and tie their comments back to them (Cooper and Haines, 2008; McLeod, 2000), and both can improve coordination. Referring back to our hypothetical encounter, we also note that needs can evolve over time: our interactant might be initially concerned that another was receiving and would respond to their messages, but once this is established, become concerned with identifying the other. Thus, interactants are likely to begin filling of a pool of *presence* awareness at the beginning of every CMC encounter, but quickly turn their attention to filling a pool of *identity* awareness. Members of a group that needs to accomplish a task might have further needs; such as becoming aware of the skills of others and learning whether they can be relied on to perform a particular task (cf., Goffman, 1961). Thus, we emphasize that awareness needs depend on both the context of an interaction and the individual needs of group members.

Proposition 4: Awareness needs are context dependent; meaning that an individual may create awareness about different aspects of others depending on the stage of the interaction and their shared task.

The four above propositions provide a better understanding of awareness as a construct, which has not been spelled out in the literature before. A clear conceptual understanding and locating of the awareness construct is necessary in order to understand awareness and the impact of technology (see below) and for devising suitable research approaches (taking into account the dynamics over time), as well as for aiming to measure different levels of awareness (e.g. in suitable experiments or field studies).

The Mechanics of Awareness Creation

Having conceptualized awareness as a dynamic, multi-aspect construct, residing in individuals, which needs active maintenance as it can grow and diminish over time, we now spell out our understanding of how awareness is created in communication encounters. In doing so, we will first cover aspects of user action, then attend to the role of the mediating technology in awareness creation.

Awareness creation as signaling and observing

We argued that interactants in a CMC encounter create awareness within themselves through their interpretation of signals from others received via the mediating technology. From this viewpoint, awareness is not simply *provided* by the technology; rather, it is the result of communicative acts in the social present: observing and signaling. People signal awareness information to others by manipulating the mediating technology; others observe and interpret these signals. Mediated communication differs from face-to-face encounters because the signaled information typically flows: (1) signals propagate through the mediating technology, meaning that they are not observed in the living present, (2) actions are not permanent until the signals are sent, meaning messages can be rehearsed prior to sending, and (3) signals from the past can usually be recalled verbatim, meaning that interactants do not have to rely on their own memories of the experienced past. Taken as a whole, this means that interactants have higher cognitive loads and have to make different assumptions about the signals they are sending and receiving versus when they are face-to-face.

In all interaction, each person's action "is determined by his assumption of the action of the others" (Mead, 1934, p. 154). In face-to-face interaction, individuals shape their interaction and interpretation of the actions of others grounded in their familiarity with a similar context, "taking the role of the other ... going through certain rites which are the representation of what these individuals are supposed to be doing" (Mead, 1934, p. 153). The fundamental driver of behavior in the initial stages of *face-to-face* interaction is a need to reduce uncertainty (Berger and Calabrese, 1975). We suggest that in a *computer-mediated* context (e.g., our hypothetical encounter), because the "world within reach" (Schütz, 1945, p. 547) is extended geographically and temporally beyond the co-present space, one can potentially be disconnected from one's communication partner and one (or the other) can appear as a "partial self" (Schütz, 1945, p. 544). This potential for "quasi-presence" extends uncertainty into areas that are taken for granted when face-to-face, because much of the contextual awareness that would be available to interactants cannot be as easily assumed.

In our hypothetical encounter, the person sitting in front of the computer was unsure about very fundamental things: was another person present at another terminal, was the other paying attention to what was said, etc. This uncertainty may not be as pronounced when initiating communication via familiar mediating technology with a familiar other, but would exist nonetheless. Thus, we have suggested that interactants reduce the uncertainty that arises in CMC encounters by collecting information signaled by others as awareness, and we suggest that this awareness is needed in order to create the "generalized other," which forms the fundamental basis for interaction (Mead, 1934). Being a social process, this means that the signals one sends are determined by two considerations: one wishes to meet specific awareness needs, and one recognizes that others wish to meet similar needs (cf., Goffman, 1967). Thus, the communication of awareness is determined by projection; as one engages in signaling, conveying certain aspects of awareness, one projects a situation and awareness needs to the others in order to determine the signals one sends to others. At the same time one expects to be similarly signaled by others (i.e., reciprocity [Burgoon et al., 1995]). Hence, the kinds of awareness signals that are created are dependent on the ways in which one perceives others; similarly, the manner in which the signals are interpreted also depends on how one perceives others (Schütz, 1945, p. 542). Ultimately, signaling and observing can be seen as two sides of the same coin in the creation of awareness. As has been argued before, they are "complementary aspects of the same coordinative practices" (Schmidt, 2002, p. 291). Complementing our above-introduced pools metaphor, the signaling activities create a stream of information that individuals can tap into in order to fill their awareness pools.

Proposition 5: Awareness via computer-mediated communication results from mutual activities of signaling awareness information and observing the information signaled by others.

Proposition 5a: Awareness information is signaled, because users project needs and expect reciprocity.

Proposition 5b: Awareness emerges as awareness information is observed and stored by interactants.

We note that signaling and observing does not have to be done consciously. In every-day encounters, signaling and observing happen fluidly, effortlessly, as by-products of familiar, coordinated communication practices (Heath et al. 2002, Schmidt 2002).

Role of technology in enabling and constraining awareness creation

Awareness as portrayed so far is not a feature of a mediating technology, but the result of communicative acts (i.e., signals) in which the technology has become embedded. In essence, we agree that “defining awareness only in terms of technical software features ignores the subtle ways in which groups are able to create awareness through their shared practices of using technology” (Riemer et al., 2007, p. 13). But while technology cannot *per se* produce awareness, it plays an unquestionably vital role in the process of awareness creation, by both enabling and constraining social action. We assert that specific technological features designed to support awareness have to be manipulated by interactants and incorporated into practice in order to facilitate awareness creation; signals ostensibly produced by technology are under the control of the interactants and may be altered or observed in unintended ways. For example, IM and Skype users have been observed to modify their screen names to display presence information, and the state of the status icon has a different meaning when such practices are adopted (Smale and Greenberg, 2005; Riemer et al., 2007).

Awareness arises from acting with and through technology. Dedicated awareness-related technology features will not aid in the creation of awareness unless they become appropriated by the interactants in their pursuit of awareness creation. However, when technologies become part of social practices, technology features drawn on in communicative acts can facilitate building a particular aspect of awareness even when the participants in an encounter do not actively attend to that particular need. For example, a reply feature in e-mail clients adds a prefix “Re:” to the subject line when replying to another’s e-mail message and copy the original message to the body of the reply. If the other is familiar with the meaning of the “Re:” and the purpose of including the original message, they can increase their awareness of a particular message’s position in the context of prior messages quite effortlessly (cf., working for the first time with another whose e-mail client adds “Aw:” instead). At the same time, this means that one can rely on one’s e-mail client to communicate such activity-related awareness and not have to actively add this information to the communication stream (e.g., “this is in response to your earlier e-mail about...”). Similarly, most mediated communication technology adds identity information to each message; meaning one typically won’t include identity information with each message (e.g., “This is Pat again, ...”). Thus, awareness creation can be sped up by dedicated technology features when embedded in user practices.

We further assert that by focusing on a particular aspect of awareness when communicating or adopting a technology feature that communicates a particular aspect of awareness with little or no extra effort, participants in an interaction build that particular aspect of awareness more effectively (e.g. at a faster rate) than others. Hence, there is a certain *volume* of each particular aspect of awareness that can be sent (e.g. background noise in a voice communication conveying the context of someone being at a train station). This volume is to a considerable extent determined by the nature and features of the technology. Noting that mediated communication has both volume and particular content, increasing the overall volume of interaction is likely to mean more rapidly building awareness over a given time (e.g., using voice communication rather than text [Walther, 1992]). This notion is consistent with theories such as social presence theory (Short et al., 1976) or media richness theory (Daft and Lengel, 1984), which suggest that technologies differ in terms of the number and nature of signals they are capable of transmitting, with some media providing richer or wider channels. Richer channels are likely to convey more and/or multiple aspects of awareness over a given time period; in essence, interactants have larger streams of signals from which to draw when using richer media that can built awareness more rapidly or even multiple aspects of awareness simultaneously. At the same time, we note that users might limit the awareness stream deliberately in order not to convey unwanted context signals (e.g. when they want to disguise their location).

On the other hand, when a mediated communication channel is limited in the amount of information that can be conveyed, one can signal others such that a relatively small amount of information is actually transmitted, but when added to “taken for granted” information, builds more awareness than would be gained by another that doesn’t take such information for granted (Garfinkel, 1967). Thus, we suggest that the negotiation of shared user practices over a familiar communication medium can build “taken for granted” awareness in others that persists across encounters and thereby increase the rate at which certain aspects of awareness are built. For example, experienced Twitter users add #hashtags to their messages that provide contextual reference points such that more awareness information is communicated in the same amount of text. Channel expansion theory (Carlson and Zmud, 1999) observes a similar effect via e-mail when comparing inexperienced with experienced users, and suggests that “knowledge bases” must be gained before a richer experience is obtained (p. 167). We suggest that such knowledge can be considered awareness about *methods of communication* that accumulates, is relatively persistent across encounters, and can be drawn upon in a way that interactants are able to communicate more awareness using the same volume of signals. This in turn means that characteristics of communication media are not fixed, but rather perceptions of media richness are contextual and contingent upon the mutual experience of users.

Proposition 6: Awareness creation via computer-mediated communication is contingent on the volume of communication, which is influenced by media characteristics and learning.

Proposition 6a: Interactants can increase the speed of awareness creation by selecting richer media.

Proposition 6b: The rate of awareness creation over a given medium increases as interactants learn and build shared practices of communication.

Drawing from the above we see that awareness creation practices can indeed be enacted based on a technology feature that was designed for that purpose (Orlikowski, 2000). Unfortunately, mediating technologies may not always gather and present information in a way that users are likely to appropriate them as part of their shared practices. Therefore, awareness creation can also be “raw” – purely communication-based. For example, although on/offline status indication is ubiquitous in synchronous CMC environments and has been suggested to provide “presence information in real time,” we noted that status indication is only a “first drop” and inadequate by itself for communicating presence, meaning it is usually combined with other practice-based presence information (e.g., a preceding question: “Can you chat?”, a status text: “Help Needed!”, or a prior arrangement: “Skype me when you see me online tomorrow.”).

In general, designers should not be surprised when users appropriate specific tools in unintended ways and/or use general features of the mediating technology to create specific types of awareness. In either case, the mediating technology carries the awareness information and as such enables the practices to emerge. The following examples serve to illustrate popular real-life instances, where users have developed new user practices of awareness signaling circumventing shortcomings of the underlying technologies, which contributed indirectly to the co-evolution of awareness signaling practices and the underlying technologies.

Studies have shown that in CMC contexts where identity information is lacking users have been observed to add this information to the “raw” communication stream, thus filling a void and satisfying an apparent awareness need for coordinating their conversations (McLeod, 2000). Moreover, Twitter was conceived of as a microblogging service, meaning that the communication was one way – from one to one’s followers. Over time, Twitter users have developed user practices that allow them to carry out two-way conversations by adding an @reply tag (i.e., @username is inserted into the message to indicate to whom the message is directed) when they are replying to a particular person’s tweet. In this way, one can query one’s followers about whether they would like to meet for lunch, and know by an @reply tag that a tweet sent by a friend 30 seconds later that says “How about BK?” is a restaurant suggestion. Thus, the implementation of the @reply tag is a user practice to compensate for a lack of identity information when giving a reply. The development and adoption of alternative Twitter clients that track @replies can similarly be seen as user practices that adapt to the lack of identity information.

We also observe the contrary, in that user practices arise in order to suppress too much awareness information, i.e. the becoming aware of peripheral activity in a communication channel. For example,

other patrons in a restaurant are present in one's cell phone conversation in the sense that they can hear one's remarks to the other; however, the others are typically not privy to the identity or activities of the person on the other end. Similarly, when following a Twitter user, one may observe entries that are directed at other users (i.e., @replies), but not necessarily observe the comment from the other that led to the reply, meaning one is privy to only half of the conversation. Being privy to a "halfalog," as opposed to a dialog, may make it more difficult for a user to select and draw out information that they need or lead them to draw out incorrect information because they make incorrect assumptions about the context of the overheard conversation (Emberson et al., 2010); in essence, it muddies the awareness stream. As a result, users have adopted Twitter clients that support suppressing messages with @reply tags in them unless one is also following the other user.

The above examples lead us to assert that whenever mediating technology does not sufficiently meet needs for awareness, users will accommodate through communication practices using other aspects of the technology. This leads us to formulating the following proposition.

Proposition 7: Mediating technologies that do not suitably convey awareness information will lead to the emergence of user practices that convey and/or coordinate such information.

Discussion and Implications

In the preceding sections, we clarified awareness as a construct and described how awareness is created in computer-mediated communication through technology-enabled user actions of signaling and observing. Our theory builds on the notion that one wishes to reduce uncertainty when communicating, but we emphasize that mediating technology broadens and increases uncertainty to the extent that each mediated communication encounter requires awareness creation behavior (cf., Berger and Calabrese, 1975). Thus, we argue that technology designers should understand that 1) needs for awareness arise when one uses a new mediated communication tool to communicate with a stranger, 2) some needs recur with each mediated communication encounter, and 3) needs may evolve as a mediated communication encounter proceeds. In summary, our analysis makes two main contributions to the literature, filling apparent gaps in understanding awareness.

First, we contribute to a better understanding and conceptualization of the awareness construct itself. We have argued that awareness is not a property of a technology, nor is it created instantly. Awareness arises over time from practices of technology-enabled actions; it is dynamic and can be viewed as different pools of awareness needs that are filled according to contextual awareness needs. Also, awareness "evaporates" if not actively replenished, meaning the needs for awareness recur when interaction ceases for a time. Moreover, awareness is an individual-level construct, not a group-level one.

Second, we contribute to a better understanding of how awareness is created. We conclude that awareness arises from technology-mediated user actions of signaling and observing. As such, while awareness itself is an individual construct, the *creation* of awareness in CMC is inherently social, embedded in practices of signaling and observing, often as by-product of larger (work) practices. We have emphasized the role of technology by suggesting that specific features can be designed to aid in the creation of awareness such that users are more likely to adopt them as part of their shared practices. We further emphasize that when mediating technology conveys certain awareness information this does not mean that awareness automatically springs up; rather, we propose that the technology feature must become part of practices of using it (cf., Orlikowski 2000). Thus, we argue for an interplay between user practices and technology, in that whenever such features are missing, or are perceived to be dysfunctional and/or not to be useful in a context, users will make up for this by creating other, often improvised ways, of creating the needed awareness, which might in turn shape the technology. Our theoretical propositions warrant further exploration and testing in future research; our findings have implications for researchers and tool designers.

Implications for Researchers

Most approaches to computer-mediated communication treat awareness as a design problem: tools need to be built to certain specifications in order to enable awareness. Gutwin and Greenberg suggest that there

are “three tasks that the groupware designer must undertake in supporting workspace awareness: understand what information to provide, determine how the knowledge will be gathered, and determine when and where the knowledge will be used.” (Gutwin and Greenberg, 2002, p. 438). Similarly, Gross et al. suggest that “existing CSCW applications only partially support...awareness,” and that in order “to enrich the existing CSCW applications with the missing features” empirical research is needed to constantly identify gaps in awareness support with the goal that “novel behaviors might be recognized that lead, in turn, to novel features, and so forth” (Gross et al., 2005, p. 356). Neither recognizes the fluid nature of social interaction and the evolving structures and information needs in groups (cf., Oemig and Gross, 2007).

From tool focus to tool-in-use

Historically, computer-mediated communication research argued a similarly deterministic view of technology’s use, expecting certain effects as a direct consequence of applying a particular communication medium or technology to a context, and was slow to recognize the role of user practices in influencing behavior and the usage of technology. For example, early media richness theorists proposed that mediated communication technologies left users without the feeling of the presence of others (Short et al., 1976), and were only appropriate for formal and less equivocal tasks (Rice, 1993). Later research showed that mediated communication was employed by managers for equivocal communication tasks (Markus, 1994), that mediated communication was appropriate for and even encouraged informal communication (Walther, 1995), and that although e-mail is ostensibly one of the leanest mediated communication technologies, it is richer in the hands of experienced users (Carlson and Zmud, 1999). Similarly, GDSS researchers generally believed that their tools would be used in specific ways and lead to specific “process gains” in decision making groups (DeSanctis and Gallupe, 1987); only to later advocate the notion that user practices in the social setting were a powerful mediating force (DeSanctis and Poole, 1994).

Thus, we note that the prominent awareness frameworks (Gross et al., 2005; Gutwin and Greenberg, 2002), although recently published, fail to fully account for the agency of users and their inventiveness and creativity in building awareness while communicating. Recent empirical research suggests that the fundamental awareness needs in mediated communication are presence, behavior, and insight awareness (Cooper and Haines, 2008). However, when designing tools to support these needs, these researchers assumed that their technology tools addressed those needs without recognizing that users actively participate in awareness creation. This led to unexpected effects when users did not adopt the tool as part of their communication practices.

Against this backdrop, we offer our theory as a means to guide future research on designing and applying technology to support awareness creation in mediated communication contexts. We suggest that future research should investigate the use of flexible communication tools that allow and enable multiple ways of awareness creation instead of trying to build elaborate forms of pre-specified awareness features into tools. Viewing computer-mediated communication as a tool-in-use recognizes the interplay of technical, individual, and social aspects of CMC use in organizational contexts (Orlikowski, 1992). We noted earlier that an IM status icon can have many different meanings, most of which have implications far beyond indicating presence awareness. For example, a change in status from offline to online on a company IM system might signal to others that one has begun working, and mean that the others should increase their efforts on their particular part of a shared task. Thus, a potential avenue for future research would be to examine how users create (shared) meaning around that icon and/or suppress its use to prevent communication of such information.

Exploring the dynamic nature of awareness

Awareness researchers have begun to recognize the evolution of awareness needs over time (Oemig and Gross, 2007), but the dynamic notion of awareness that is integral to our theory remains largely under-researched. Future research should explore how awareness needs are met and shift over time in order to further our understanding of the flexible role of technologies in awareness creation and the corresponding user processes of adaptation and appropriation. In doing so, our conceptualization of awareness accounts for the evolution of needs for awareness and the ability of users to direct technology to fulfill those needs.

In essence, we recognize that communication technology is the medium that carries the streams of awareness-related information, but users extract and direct that information to their pools of awareness.

More specifically, researchers might also explore the extent to which certain awareness pools are filled in specific encounters of groups as they meet over time (cf., Wheelan, 1994; Wilson et al., 2006). We have proposed that awareness develops gradually from very basic notions, for example, the mere presence of others, to very elaborate understanding of aspects of others – their physical, locational presence and/or their future intentions. However, little is known about the amount of information that is wanted at different stages of an encounter or across encounters. A typical research question might be: How much of certain types of awareness do people need to be able to work effectively in a given mediated communication situation?

As for suitable research methods, rich methods for data collection are needed to appreciate and grasp existing social practices and their complexity and embeddedness in organizational contexts. For doing so, workplace observations are very well suited to gain an understanding of how people draw on and use mediating technology in distributed work and awareness creation. On the other hand, experimental studies may be best able to control for individual, group, and technology influences on awareness creation practices.

Implications for Tool Designers

Awareness researchers advise practitioners to design tools such that they support users in filling certain fundamental needs for awareness (Cooper and Haines, 2008; Gross et al., 2005; Gutwin and Greenberg, 2002; Jang et al., 2000). Using the pools metaphor, we offer a sense of why some elements of awareness are so critical: by turning their attention to filling a fundamental need, such as presence or identity (in some cases before any other interaction occurs), these tools allow users to immediately add other aspects of awareness to their interaction stream. We suggest that these other aspects of awareness are likely more context-specific and may likewise be more critical for the groups in getting organized and accomplishing their specific tasks (cf., Wilson et al., 2006). We have also noted that awareness information must be presented in a suitable manner or else users will adopt practices that convey and/or coordinate that information.

Finally, we emphasize again that technology both constrains and facilitates awareness creation, meaning that a new tool might encourage the development of practices that build awareness more quickly (e.g., Facebook's news feed), but removing a tool immediately disables any practices that were enabled by the tool. Thus, tool designers should recognize the extent to which existing tools have been incorporated into user practices of awareness creation when changing/upgrading tools, even if such tools upon analysis are shown to not exhibit dedicated awareness creation features. If a tool suddenly changes such that it is inconsistent with and/or eliminates existing practices of awareness creation, users are likely to resent such changes – at least until new practices are developed in the shared context.

Conclusions

In this paper we have challenged a technology-centric view of awareness and offered a conceptualization of 1) the construct itself and 2) of the process of awareness creation. In doing so, we conceived of awareness in mediated communication as building in pools. Awareness emerges from user actions; meaning that interaction via computer-mediated communication is directed according to desires to fill various needs for awareness. We proposed a theory of dynamic awareness creation that acknowledges the active role of the user in meeting awareness needs. Our theory 1) re-conceptualizes the nature of awareness as being dynamic and evolving: awareness is not instantly created, but *develops gradually*, often slowly, and can decline over time, 2) clarifies the mechanism of awareness creation: awareness *emerges from communicative actions*, 3) argues that salient objects of awareness are *not pre-specified* and constant within a given context, but occur and change according to the needs of users, and 4) specifies the role of communication technology in the awareness creation process: awareness in mediated contexts is *enabled by communication technology*, meaning that technology plays both a facilitating and constraining role in the creation of awareness and that it is also appropriated and (re-)interpreted by its users.

With this work we contribute to ongoing research on awareness in distributed work. Our theory appreciates the role of the user in adapting, shaping and appropriating technology and their ability to direct technology to flexibly fulfill their changing needs for awareness. Moreover, it widens the view for designers and managers by suggesting a more holistic exploration of the creation of awareness in social contexts. Using our theory, tool designers, managers, and researchers can recognize the potential for awareness needs to evolve, while explicitly accounting for a user's desire to direct interaction according to their need for awareness and their perceptions of the needs of others. Rather than concentrating on the development of new technology to create particular types of awareness, our work shifts the focus to selecting and using technology that flexibly supports the emergence of awareness creation practices. Awareness creation in this respect is treated not only as a design problem, but also as a technology selection, appropriation and management issue. Consequently, we argue that a perspective recognizing computer-mediated communication as technology-in-use (Orlikowski, 1992) is needed in order to advance knowledge in this domain, moving beyond a technology-created view and treating awareness creation as a gradually emerging product of social practices.

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