11-20-2008

Pools and Streams: A Theory of Dynmic,Practice-based Awareness Creation in Mediated-Communication

Kai Riemer
The University of Muenster, kai.riemer@sydney.edu.au

Follow this and additional works at: http://aisel.aisnet.org/sprouts_all

Pools and Streams: A Theory of Dynmic, Practice-based Awareness Creation in Mediated-Communication

Kai Riemer
The University of Muenster, Germany

Abstract

In face-to-face contexts, information about the activities, context, emotions, etc. of others is typically available and often taken for granted. In mediated settings, this awareness information must be actively signaled by technology or users. In this conceptual paper, we offer a theory of the dynamic creation of awareness in mediated settings using a metaphor of pools fed by streams of communication. Pools of awareness are held within users and gradually fill via signals from others. Users desire different pools to be filled before others and direct the streams of interaction to feed those pools first. Furthermore, the desired pools are context and media dependent, but presence, identity, and activity appear to be fundamental to mediated communication: fed early and taken for granted later. Finally, pools drain if not actively replenished, and fundamental pools must be refilled when a new encounter begins. We formulate theoretical propositions according to our line of reasoning and discuss implications of our proposed theory for mediated communication researchers and practitioners.

Keywords: awareness, mediated communication, presence, theory building

POOLS AND STREAMS: A THEORY OF DYNAMIC, PRACTICE-BASED AWARENESS CREATION IN MEDIATED COMMUNICATION

Abstract

In face-to-face contexts, information about the activities, context, emotions, etc. of others is typically available and often taken for granted. In mediated settings, this awareness information must be actively signaled by technology or users. In this conceptual paper, we offer a theory of the dynamic creation of awareness in mediated settings using a metaphor of pools fed by streams of communication. Pools of awareness are held within users and gradually fill via signals from others. Users desire different pools to be filled before others and direct the streams of interaction to feed those pools first. Furthermore, the desired pools are context and media dependent, but presence, identity, and activity appear to be fundamental to mediated communication: fed early and taken for granted later. Finally, pools drain if not actively replenished, and fundamental pools must be refilled when a new encounter begins. We formulate theoretical propositions according to our line of reasoning and discuss implications of our proposed theory for mediated communication researchers and practitioners.

Keywords: awareness, mediated communication, presence, theory building

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). When working remotely and using meditated communication, information about others, their activities, context, emotions etc. is lost when compared with traditional face-to-face contexts (Scupelli et al., 2005). While awareness of others and their activities is relatively easy to maintain or even taken for granted in traditional co-located, face-to-face contexts (Gutwin and Greenberg, 2002), lack of awareness is believed to create the coordination problems typically seen in distributed work, such as inter-group conflicts (Rennecker, 2005).

Research and design practices in computer-supported cooperative work (CSCW) and human-computer interaction (HCI) propose that collaboration is enhanced when systems communicate awareness information about the presence and activities of the others in the shared workspace

(Gross et al., 2005, Gutwin and Greenberg, 2002). Thus, the dominant view in the literature favors a technology-centered viewpoint, which typically approaches development with a list of suggested awareness features that should be incorporated into systems to foster collaboration (Gutwin and Greenberg, 2002). According to this notion, awareness via mediated communication is provided by technology; the mediating technology either provides a particular form of awareness about the other or it does not.

In contrast with this view, more recent observations suggest that users of collaboration systems often manipulate the features of mediated communication systems to create awareness in ways that were not predicted by the designers (Frößler, 2006, Riemer et al., 2007). Thus, we adopt a practice-based perspective on awareness creation and set out to explore a dynamic notion of awareness creation, arguing that awareness is not a dichotomous state and is not created by technology. As we will argue, the predominant technology-centric view of awareness fails to appreciate the role of human actors in appropriating technologies and in creatively inventing new ways of communicating that facilitate awareness creation, even in settings where mediating technologies are not targeted at creating awareness. In contrast with the technology-centric view, a practice-based perspective is able to account for the variety of ways in which awareness is created by people in social contexts.

We propose a theory that captures the dynamic notion of awareness and moves beyond a technology-centric view in that it treats awareness as a product of communicative practices that are adapted to technology. To facilitate our discussion, we introduce the metaphor of awareness as *pools* filled gradually by directing *streams* of communication. Under this dynamic notion, users of mediated communication create and shape signals (the streams) to feed pools of awareness within themselves and others. Furthermore, all aspects of awareness are not desired simultaneously; rather, users have needs for different aspects of awareness, and these needs evolve as other awareness needs are satisfied. The pools and streams metaphor is a means to organize mediated communication technology design and user-based adaptations to mediating

technology into a cohesive framework that accounts for the evolution of needs and the ability of users to adapt technology to fulfill those needs. Our theory aims to (1) re-conceptualize the nature of awareness, (2) explain the mechanisms of awareness creation (as part of social practices) and (3) propose a set of fundamental awareness needs.

Adopting a human-centered, practice-based view of awareness enables us to understand how and why awareness emerges through communication. Using our framework, tool designers and researchers can recognize the potential for awareness needs to evolve, while explicitly accounting for a user's desire to direct interaction among various aspects of awareness according to their needs and their perceptions of the needs of others. Our framework also appreciates the role of the user in adapting, shaping and appropriating technology and their ability to direct technology to flexibly fulfill their changing awareness needs. Moreover, it widens the view from a design and management standpoint by suggesting a more holistic exploration of the creation of awareness in social contexts. Rather than concentrating on the development of new awareness technology, our framework 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 adoption and management issue.

We begin with a review of the predominant view of awareness as being technology-centric and contrast it with the emerging practice-based view of awareness creation that forms the basis of our theory. Next, we offer a thought experiment in which we envision a situation in which no awareness of others exists and illustrate how fundamental needs for awareness shape mediated communication. Then, we introduce the body of our theory: a dynamic model of awareness creation in which awareness is conceived of as being held in pools, which are fed by interaction streams directed by users. We formulate a set of propositions to capture the essence of our theory. We close the paper with a discussion of implications for IS researchers and practitioners.

Conceptualization of awareness in the literature

Awareness is generally seen as "an understanding of the activities of others, which provides a context for your own activity" (Dourish and Bellotti, 1992, 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, 541). Researchers in computer-supported cooperative work (CSCW) and the Human-Computer Interaction (HCI) have become particularly interested in the concept of awareness and its creation through the use of technology, proposing that collaboration is enhanced when the corresponding systems communicate awareness information about the presence and activities of the others in the shared workspace, and providing designers with a list of suggested awareness features that should be incorporated into systems to foster collaboration (Gross et al., 2005, Gutwin and Greenberg, 2002).

Awareness is the result of technology

As noted earlier, the creation of awareness is treated in the CSCW and HCI literature as a design problem mastered through a development process that aims to enable certain types of awareness by means of specific technological features (e.g. Gutwin et al., 1996, Koch, 2005). In doing so, different types of awareness are typically distinguished according to the reference object to which the awareness is directed - for example, task-related awareness is in relation to the activities of people, or social awareness is in relation to emotional states of others (Gross et al., 2005, Robertson, 2002). Awareness as such is seen as provided by technology; specialized awareness applications are developed to address awareness problems (Boyer et al., 1998, Ljungstrand and Segerstad, 2000); IT artifacts provide certain awareness functions (Scupelli et al., 2005) or features (Borning and Travers, 1991); they gather and provide awareness information (Jang et al., 2000) in order to promote (Rennecker, 2005) or support awareness in collaborative work (Gutwin and Greenberg, 1996). Research projects in this tradition 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). Consequently, the dominant view of awareness is a technology-based view, which treats awareness as a product (or even a feature) of technology.

Awareness is created instantly

By thinking of it as a product of technology, awareness is consequently seen as being created instantly. 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 that the user's computer system is online (Carmona, 2008); in essence, the application has registered with the IM server (Luo and Liao, 2008). Awareness of presence via IM is thus created instantly by way of deriving, transporting and revealing the necessary information (i.e., only delayed because of the time required to start the application and connect to the status server); some authors have even argued that tools such as IM "support awareness of presence in real-time" (Ljungstrand and Segerstad, 2000, 22).

Awareness is a state

It can be inferred from the above that awareness in the literature is mainly treated as a state; when a particular aspect of awareness is provided, that aspect is fully fashioned in that instant. Hence, under this notion awareness of status via IM is complete: visualized for the user and others with different icons and/or colors (Herbsleb et al., 2002). By thinking of it as a state, awareness is also seen as being dichotomous; in essence, a user is either not aware or aware of a particular aspect of their mediated environment. Essentially, the argument is that awareness is created in systems by capturing information and presenting it to users (Gutwin and Greenberg, 1996). Similarly, awareness features are offered to users of other IT artifacts; in social networking sites by listing the status and profile changes of their friends, to players in online multiplayer games by providing otherwise hidden information about another player's interactions with the gaming application (Moore et al., 2007), and to visitors in a museum by notifying them

when others are looking at or virtually accessing information about the exhibit they are viewing (Gross and Specht, 2001).

In summary, the dominant view in the existing literature is to treat awareness as a *property of technology*, in essence, that awareness is something to be built into or that is *instantly created* by the technology. It is conceptualized as a *state* and it is implied that awareness as a state can be *complete*. In the following we will challenge this technology-centric notion of awareness and pave the way for a theory that treats awareness creation as a dynamic process embedded in social practice.

Toward a theory of dynamic, practice-based awareness creation

While CMC and HCI research has focused on different objects and types of awareness, discussed the need for and implications of awareness, and explored to a great extent the design of technologies to produce awareness, relatively little is known about how awareness emerges in mediated communication as the result of communication practices (Riemer et al., 2007). Only a few recent papers have argued for a dynamic notion of awareness as being based on the communicative practices of users instead of simply being created by technology (Heath et al., 2002, Riemer et al., 2007, Schmidt, 2002). However, this dynamic notion was neither conceptualized nor theorized further.

Riemer et al. (2007) explored awareness creation in five cases in which the same IT artifact was used for communication and awareness creation purposes. The authors found a surprising variety across the cases of both the types of awareness and the ways in which awareness was created. They argue that awareness, as created in context, goes "way beyond what can be expected from the tool and its 'built in' awareness capabilities." (Riemer et al., 2007, p. 1). Thus, we suggest that awareness and its creation are not adequately explained by the existing conceptualization of awareness. Other scholars have similarly argued that awareness is a learned, embodied, skilful 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). Technology is

therefore subject to interpretation and appropriation, and awareness can only be achieved by the skillful activities of participants in a shared environment who draw upon technology resources in the creation of awareness (Riemer et al., 2007).

While a practice notion has been proposed, to our knowledge no work exists that discusses in a systematic and coherent way the production of awareness as a dynamic process with awareness being something that is built gradually by users and which can also vanish over time. In the next sections, we clarify our motivation for choosing a practice-based view of awareness creation and introduce the idea that awareness needs in mediated communication evolve over time.

Awareness is created through social practice

As noted earlier, the practice notion treats awareness as emerging from communication practices (i.e., the manipulation of technology) rather than as a property of technology. Those that favor this more human-centered, practice-based view of technology note that the users of communication and collaboration systems often use the technological features in quite unexpected ways (i.e., in ways not predicted by the designers) (DeSanctis and Poole, 1994, Huysman et al., 2003, Oemig and Gross, 2007). The practice-based approach to awareness appreciates the active role of humans and their shared communication practices in the creation of awareness (Riemer et al., 2007). This notion does not neglect or even reject technology's influence on awareness creation: we take a position that acknowledges the duality of design and practice in the use of collaboration technology – designers create the features that users use to create awareness. Thus, the process of creating and communicating awareness information among users is shaped by the limitations of a particular technology platform, but users can adapt their communication and increase awareness within the bounds of technical limitations by shaping their behavior (cf., Walther, 1992).

A dynamic notion of awareness creation

Furthermore, we conceptualize awareness as something within users that may build up slowly rather than being instantly created and that needs maintenance rather than being simply fulfilled. Thus, we introduce a dynamic, evolving notion of awareness – the formation of different aspects of awareness over time by interactants. We will argue that different aspects of awareness about one's environment do not develop at the same time; rather, certain aspects of awareness are sought first and, once attained, lead one to seek awareness about other aspects. In doing so, we will also move away from a static and general classification of awareness types and suggest that awareness needs are highly context- and interactant-dependent: the types of awareness that are needed and thus attended to by interactants vary by context and individual, and those needs evolve over time.

Consequently, we suggest that awareness in mediated environments (1) is based on, or more precisely, *emerges from social practice,* and thus does not emerge solely from, nor is it entirely limited by technology; (2) is not instantly created, but *develops gradually*, often slowly, through the practices of users; and (3) that the salient objects of awareness are *not pre-specified* and constant within a given context, rather the salience of objects is dynamic and changes according to the needs of users.

Theory development

In the following we propose a theory for explaining awareness and its creation in social encounters. Following the taxonomy proposed by Gregor (2006) our theory qualifies as a type II theory, a theory that aims at explaining how and why things are. In that respect, our theory aims at making three contributions to further our understanding of awareness: (1) explaining the nature of awareness (how should awareness be conceptualized?), (2) explaining the mechanisms of awareness creation (how is awareness created?), and (3) introducing the idea of fundamental types of awareness and the otherwise situation-dependent nature of awareness needs (why is awareness needed in distributed social encounters?). In order to do so, we will introduce the

pools and streams metaphor as a means for capturing the dynamic nature of awareness and present a set of propositions that further clarify the understanding of awareness creation.

While our theory aims at explaining awareness and the mechanisms that facilitate its creation, it does not aim at making generalizable predictions that can be readily tested in empirical research (type IV theory). This is partly due to the context-dependent nature of the types of awareness needed (i.e., we propose that awareness needs to vary in specific social contexts). However, in the discussion section. we will briefly discuss ways of operationalizing our theory and deriving hypotheses about awareness needs in specific application contexts. .

We begin with a thought experiment, which envisions a situation where virtually no awareness of others exists, and illustrate how different aspects of awareness are created by way of communication and how awareness of others gradually develops over time. As such, the thought experiment serves two purposes. Firstly, it introduces the most fundamental types of awareness, which we suggest are universal and needed independent of context. Secondly, it provides a first illustration of the dynamic view of awareness creation, in which awareness is conceived of as being held in pools that are fed by streams of information that are directed by users. The main body of the theory is then presented afterwards as a set of propositions clarifying in detail the nature of awareness and the mechanisms of awareness creation. We conclude with implications for research and practice.

Fundamental awareness needs in distributed communication

The following thought experiment introduces the most fundamental types of awareness by illustrating a situation in which no awareness exists at the beginning of a social encounter. We acknowledge that this situation is to a certain extent a simplification, but we believe that a thought experiment allows us to clarify the basic mechanisms and underlying concepts of awareness creation in a mediated communication context.

Thought experiment

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, only a flashing cursor. 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 he/she enters something, which comes from his/her prior experience with "experimenters," "computer terminals," and "chat programs."
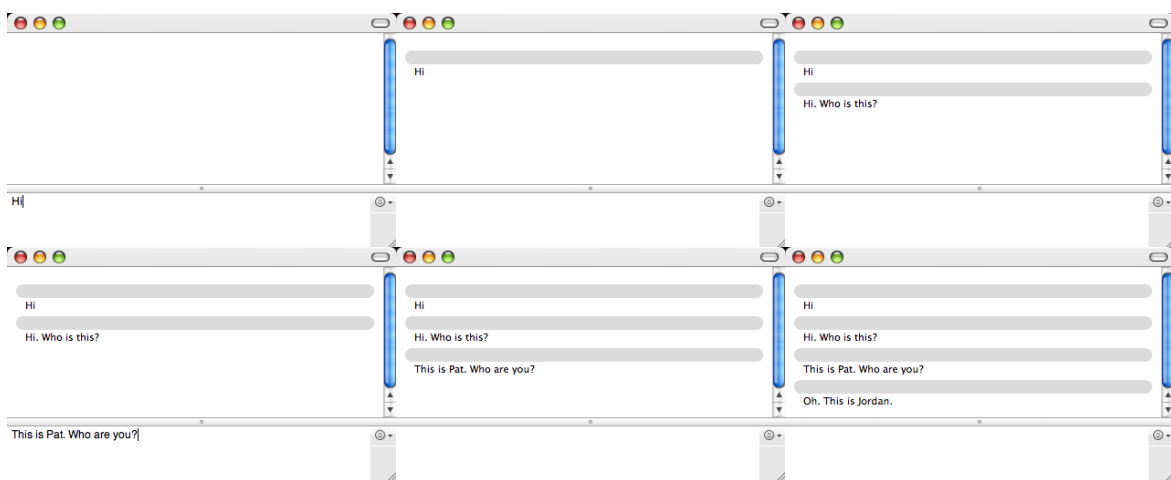

Figure 1: Transcript of Thought Experiment Chat

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. He/she 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.

This situation illustrated in our thought experiment is different from most communication in that there were relatively few assumptions that were made by the participant up front. Initially, there is little sense that another person will receive and respond to his/her messages. 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 which he/she is communicating. Over a longer conversation, he/she might learn the likes/dislikes of the person, aspects of the physical environment in which the other is located, etc.

Our aim in portraying this thought experiment is to offer the notion that when people interact via mediated communication (computer, telephone, teletype, or otherwise), there is a minimum amount of awareness that must exist within an individual before interaction will occur. Furthermore, once this minimal level of awareness is achieved, each person will desire to meet certain additional information needs about the others (cf., Berger and Calabrese, 1975). These information needs are filled by awareness, and we suggest that some needs are more fundamental than others.

Presence

In our thought experiment, and in any mediated communication, the minimum need of a person seems to be a belief that another might receive and respond to their messages, in essence, to answer the question "Anybody there?" (Jarvenpaa and Leidner, 1999, 9 and 16). As interaction proceeds, this awareness can build so that one has a sense that another will quite assuredly respond within a few moments, and, given sufficient time and message exchanges, build to the point where one has a feeling that another is attending to the interaction in much the same way that one would sense it when face-to-face (i.e., propinquity) (Walther, 1992). It is important to clarify at this point that our notion of presence so far refers to the presence in a virtual space. Hence, it could also be termed 'virtual presence' to distinguish it from the bodily presence of someone in the 'real' world. Giddens (1984) denotes with presence a 'being there' (i.e. *Dasein*) of someone; a bodily existence, which refers to the being in a physical location or context, engaged in and/or available for communication. But Giddens also recognizes that "although the 'full conditions of co-presence' exist only in unmediated contact between those who are

physically present, mediated contacts that permit some of the intimacies of co-presence are made possible in the modern era by electronic communication" (Giddens, 1984, 88). Hence, in mediated communication, awareness of the other's presence can extend to a degree that a sensation of co-presence occurs (Riemer et al., 2007).

In a mediated context, one also has to be physically present in that one must be located near and capable of manipulating a mediating technology (Riemer et al., 2007). However, others do not necessarily need an awareness of one's physical location, although this may emerge with more messages. Consequently, in mediated communication, awareness of the presence of others can range from the most basic sense that "someone is out there" (i.e., *Gegenwart*) to a point where one also gains an understanding of the bodily presence and context of others in the real world (e.g. the other is sitting at a desk in an office near a phone) and which might lead to a sensation of nearness or co-presence.

Thus, we suggest that the most fundamental need in mediated communication is awareness that another is *present*. In our thought experiment, the desire for minimal presence awareness is communicated in the first message: "Hi," and is filled with the response "Hi. Who is this?" After awareness of another's presence has been established (i.e., he/she knows that someone else is present in the virtual environment), we suggest, although they may be attended to later, two other forms of awareness are equally important to interaction via mediated communication.

Activity

Activity refers to the degree to which one is aware that something has happened, is happening, or is likely to happen in the shared virtual space (Gross et al., 2005, Gutwin and Greenberg, 2002, Steinfield et al., 1999). Awareness of activity likewise ranges, from a sense that something might happen to knowledge of what has happened, perhaps eventually reaching the point where one may feel that he/she understands why things happened and has a sense of what will happen next. Activity awareness is fundamental in that one could not really be considered interacting in the shared space if one could not observe the messages and activities of another, and similarly, if one

did not feel that one's actions were being observed by others. Activity awareness is provided as the mediating technology communicates the messages and/or behavior of others in the shared space. In our thought experiment, activity awareness minimally arises as the first "Hi" appears in the upper section of the chat window, and rises further when the response "Hi. Who is this?" appears.

Identity

Identity refers to the degree to which one is aware that others in the mediated space are distinct individuals (Gross and Specht, 2001, Gutwin and Greenberg, 2002). Identity awareness ranges from a sense of the quantity of others that are present (i.e., feeling that one or several others are present) to a feeling that one can distinguish among distinct others (i.e., *Unterscheidbarkeit*), perhaps eventually reaching the point where one may feel that he/she can precisely quantify the number and personally identify the others in the shared space. This awareness is increased as one observes that distinct others are acting in the shared space. We emphasize that the identity awareness need may not necessarily require knowing the given name of the others (a.k.a. organizational identity); rather the initial need may simply be a desire to sense the others present as individuals rather than being an amorphous mass of "others". A desire to know, and eventually knowledge of given names arising later in an interaction exemplifies our notion that awareness can vary over time. In our thought experiment, identity awareness arises as the person begins to feel that one other person is present in the mediated space. This happens as the comments of the other appear, and the apparent continuity of the comments: in the reply "Hi. Who is this?", the "Who is this?" is assumed to indicate that another person has received the first message and is responding. With "Oh. This is Jordan", the "Oh" is assumed to be a reply to the prior comment, and increases awareness that only one other person is present. Messages about likes/dislikes, previous experiences, etc. further enhance the identity of the other.

We suggest that identity awareness is distinct from activity awareness in that it is possible for one to observe and understand the activities in a mediated space without needing to have a clear

idea of which entity had performed which activity. Thus, the activity and comments of others can potentially be observed and responded to without necessarily needing to know the identity of the others interacting in the shared space (i.e. it is possible to interact with an undefined number of 'others'). Similarly, there may be features of the mediating technology that communicate the identity of those present in the mediated space without requiring any contributions by them. This distinction between activity and identity awareness facilitates the ideal of being able to interact anonymously via mediated communication without fear that others will be able to identify, and thus evaluate one's comments. However, we note that identity awareness has been shown to emerge in anonymous situations with user practices or given enough activity in the shared space (cf., Hayne et al., 2003, McLeod, 2000, Walther, 1992), suggesting that users will eventually direct themselves to linking activities to a particular persona.

Role of Awareness in Reducing Uncertainty

In all interaction, each person's action "is determined by his assumption of the action of the others" (Mead, 1934, 154). In face-to-face interaction and via familiar communication media, individuals shape their interaction and interpretation of the actions of others in the context of their prior experience 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, 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 less familiar *mediated* context (e.g., our thought experiment), uncertainty is increased even further and extends into other areas because much of the contextual awareness that would be available to interactants in face-to-face communication cannot be as easily assumed, even when displayed directly by the technology. Thus, we propose that interactants reduce the uncertainty that arises in mediated communication by actively signaling their presence, identity, and activities to others, and that these and other aspects of awareness are needed in order to create the "generalized other", which forms the fundamental basis for interaction (cf., Mead, 1934).

In mediated communication, information about others is limited when compared with face-to-face interactions. In our thought experiment, the person sitting in front of the computer may be unsure about very fundamental things that would be taken for granted when speaking face-to-face or when using a familiar mediated communication with a familiar other. We recognize that individuals do indeed wish to reduce uncertainty in the initial stages of interaction, and our thought experiment is prototypical of an initial interaction involving strangers (Berger and Calabrese, 1975); however, reflecting the need to consider the other when interacting, we suggest that one has a particular set of *fundamental* notions about others for which uncertainty needs to be reduced. In mediated communication, these include the aspects of awareness we noted earlier: whether others are present, whether activity will take place, and how to distinguish among the others. We further suggest that these notions about others accumulate as the signals are exchanged via the communication technology. In the following section, we introduce our conceptualization of the creation and maintenance of awareness through user actions using the metaphor of pools that are filled by streams of communication: we describe as *pools* the different aspects of awareness that are gradually filled as user actions direct *streams* of signals to create awareness (i.e., by manipulating the features of the communication technology). The pools and streams metaphor also frames our notion of the sequential emergence of different types of awareness in the course of communication as illustrated in our thought experiment.

A Theory of Awareness: Pools and Streams

When a person is immersed in an unfamiliar context with little empirical information about their surroundings (e.g., the man waking up in darkness in *The Pit and the Pendulum* (Poe, 2003), the interactants in our thought experiment), their awareness of everything emerges slowly and builds upon very basic components: whether there are other objects (or people) in the space, what are the dimensions of the space, where are the other objects in the space, what are the characteristics of the objects in the space. We suggest that these different aspects of the environment about which one is or desires to be aware should be thought of as separate *pools* of awareness.

Moreover, we propose that awareness is formed from *streams* of information, which fills the pools. The streams are directed by the practices of the interactants, as when a user provides a specific component of awareness (i.e. filling a particular pool). In the earlier thought experiment, the reply "This is Pat" represents a stream directed to identity. Streams can also be technologically directed, as when a chat room attaches a first name or other identifier automatically to every comment. In the following, we first elaborate on the notion of the pools, before discussing the mechanism for filling the pools, which is via streams that are directed by the communication practices of users. As we elaborate and discuss the implications of pools and streams of awareness, we will formulate a set of propositions that explain the key aspects of our awareness understanding.

Pools of awareness

We propose that the various types of awareness be conceived of as pools that are filled over time as interactants direct streams of signaling information. In our thought experiment, the presence pool fills as the other sends messages: at first, one can only be sure that another responded to the first message; over time, he/she will begin to feel that the other will remain present and not unexpectedly stop responding. The presence pool can continue to fill, meaning the awareness of the other's presence might extend to a more profound understanding of the other person's bodily context. Hence, we argue that awareness of others emerges as a pool starts filling (e.g. in our thought experiment the initial exchange might be seen as the 'first drop' into the pool); as interaction proceeds the pool then continues to fill over time, which can lead to a more profound level of awareness. Consequently, the notion of a pool exemplifies how there can be relative levels of awareness over the course of an interaction. 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.

In contrast to the technology-centered view, we also emphasize that interface elements that are designed to convey awareness do not inevitably lead to a *full* pool. As noted earlier, an IM

interface typically shows a list of contacts by screen name, along with their status: online, busy, away, or offline. However, while a status icon that shows "online" may heighten awareness of the others' presence, the presence awareness pool is not completely filled through this kind of information. As examples, (1) the person may have stepped away from their computer without updating their status, (2) someone else might be using that person's computer, and (3) the person might be working on another task not actually available for interaction. Similarly, 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 their computer when video conferencing, one may not be completely sure that he/she is attending to the conversation until he/she speaks.

> *Proposition 1: Awareness develops gradually over time. In essence, awareness behaves like a pool that is filled by streams of interaction over the course of an encounter.*

Taking the pools metaphor a step further, we also suggest that awareness declines over time when signals from others stop. 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 two hours later is less certain, and one may not have a sense that anyone will be present at all after several months. Thus, we suggest that pools of awareness must be actively replenished because they gradually drain over time. Similar draining effects are likely to occur via asynchronous communication such as e-mail or web forums – when others do not respond to ones messages or posts; one's pool of awareness about their presence will decline.

> *Proposition 2: Awareness requires active maintenance or else it declines over time. In essence, awareness pools drain over time.*

Recognizing that each interactant might deal with the uncertainty in mediated communication differently, we further suggest that these pools of awareness are within the interacting individuals. Pools of awareness are not a group level phenomenon, meaning that there is not a general store of awareness for a group; rather, the members of a group are likely to have different levels in their pools, based on their own prior experiences and interpretation of the signals of

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

> *Proposition 3: Awareness is an individual and not a group-level or workspace-level construct. In essence, awareness pools are located within people.*

Our first three propositions described the dynamic nature of awareness of being conceived as pools within people that fill gradually and can drain over time. The following propositions further clarify how pools (i.e., awareness needs) in individuals are linked to each other within individuals and the others with whom they interact. Similar to theories of group development (Tuckman and Jensen, 1977; Wheelan, 1994), we suggest that some types of awareness must at least be attended to before an interactant using mediated communication will attend to others. As elaborated on in detail in our thought experiment, the most fundamental component of awareness in a mediated communication environment seems to be presence, or the feeling that others will attend to one's signals; this awareness is formed by signals provided by the application and/or by others. Once one feels that others are present in the environment, other types of awareness will be sought, the most basic of which are activity and identity. We propose that these three types of awareness needs are universal across contexts.

> *Proposition 4: The fundamental types of awareness (i.e., pools) in mediated communication are presence, identity and activity.*

As a particular pool is filled to a certain extent, one can begin to take that aspect of awareness for granted. For example, once one can take for granted that the other will remain present and not unexpectedly stop responding, that store of presence awareness means that he/she can move on to other matters (e.g., determining the identity of the person); not having to re-establish the presence of the other before sending each message. Thus, we suggest that, depending on the needs of the interactants, certain types of awareness will be prerequisites for others (Figure 2). In

general, identity awareness will not be sought until there is at least a minimal sense of presence awareness; likewise, activity awareness will not be sought without minimal presence awareness.

The different types of awareness accumulate (i.e. the different pools fill) as the interaction proceeds, providing one with a store of information upon which to base later signals to others (i.e., a sense of the generalized other). Hence, awareness in a communication encounter can be thought of as a hierarchy of awareness pools, with lower level pools including aspects of awareness such as roles, preferences, skills, emotional states, etc. The hierarchy of awareness pools that was discussed in the thought experiment is shown graphically in Figure 2. We emphasize that prerequisite pools, once filled, do not spill over to automatically fill other pools. In Figure 2 we connect the pools using arrows. However, the arrows are there only to indicate those pools that are prerequisites to others. We propose that later pools are dependent on prior pools in that the prior pools will need to have a minimal level of awareness (i.e., a "first drop") before the later pool will be filled, but that the information used to fill the prior pool does not "spill over" and fill the later pool. For example, a message that is accompanied by a photograph and name can simultaneously convey identity and activity, but having identity information on each message does not mean that identity information "spills over" from the identity pool into other pools once it is filled, rather, identity will just be taken for granted (i.e., that aspect of awareness in the stream will be taken for granted). Thus, the later pools are fed because the interactants are choosing to direct their attention (i.e., their streams – see below) to another matter once they feel the prerequisite pools have been adequately filled.

> *Proposition 5: In a mediated communication encounter, some aspects of awareness are prerequisites of others. In essence, the pools take the form of a hierarchy.*
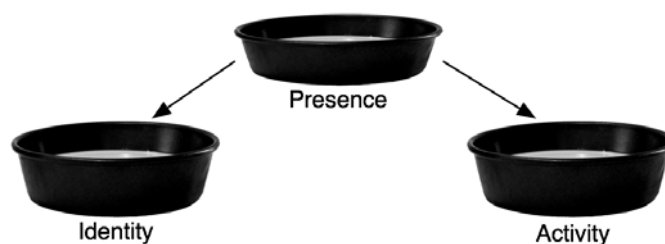

Presence

Identity   Activity

Figure 2: Pool Hierarchy in Thought Experiment

In order to further illustrate the hierarchy of pools, in the following sections we discuss examples of awareness creation in consensus groups and task-oriented groups. An extended example of the hierarchy of pools of awareness via mediated communication is a situation in which members of a group are told to reach agreement on a jury award (Figure 3). When their comments are completely anonymous, the group members apparently feel that they need to be able to individually identify (differentiate between) the comments of other members, leading them to insert identifiers into their comments (McLeod, 2000)[1]. Thus, in this situation, minimal awareness of identity is needed to enable group members to become aware of the preferences of other members. Awareness of the preferences within the group is needed before group members determine the degree to which they will be influenced by others, which must occur before the group can reach agreement (Haines et al. (2006) found less group influence when identifiers were not used).

---

[1] Similar behavior is observed in anonymous online forums.

Presence
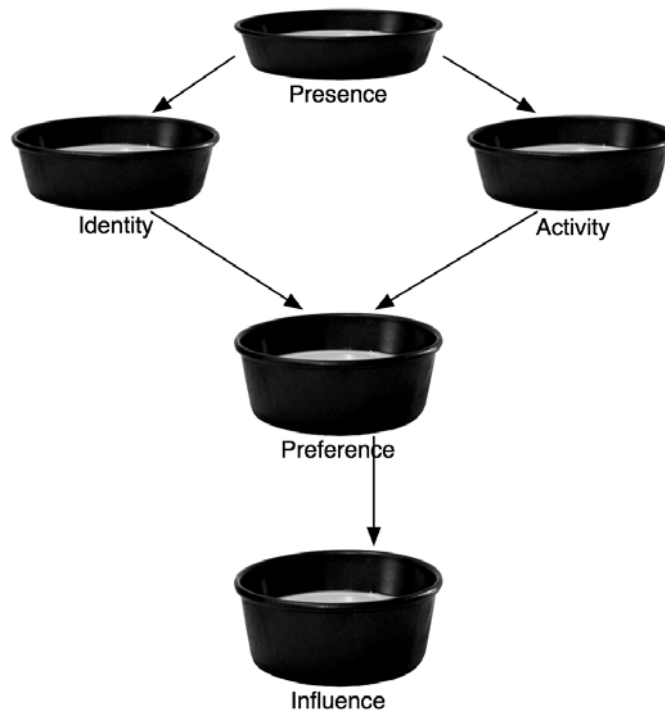
Identity

Activity

Preference

Influence

Figure 3: Pool Hierarchy in Agreement Group

However, in task-oriented groups, the hierarchy of awareness needs leads to a different goal, with users focusing instead on becoming aware of the skills of specific others so that roles can be effectively assigned (Goffman, 1961). For example, virtual team members apparently feel that they need to know a person's skill at accomplishing an information-processing task in order for them to be assigned a particular role in the group (Haines and Scamell, 2003). Roles and structures within a task-oriented group also evolve as group members become more aware of each other, using their context-dependent set of pools (cf., Oemig and Gross, 2007). In a task-oriented group these pools seem to begin with awareness that others are present, an awareness of their distinct identities, and awareness of the activities that are taking place. As these attain minimal pools, group members appear to then wish to become aware of the degree to which one possesses a particular skill and is dependable; then they can become aware that one can be cognitively trusted to fulfill a role (McAllister, 1995). Taking this still further, before building awareness about whether one is appropriately assigned to a role, group members might desire pools of awareness about whether one is available and can be cognitively trusted (Figure 4).
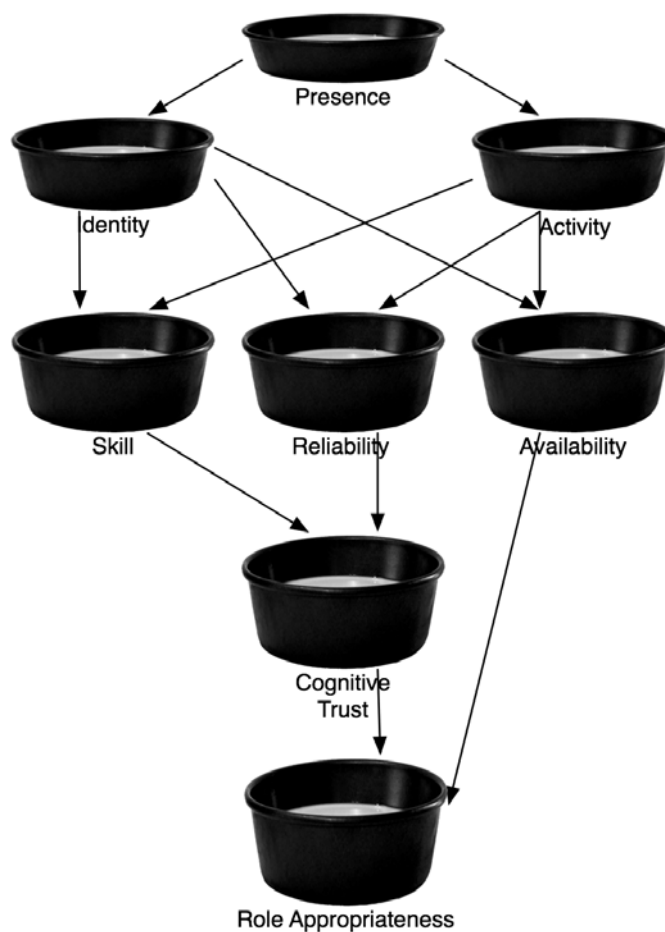
Figure 4: Pool Hierarchy in Task-Oriented Group

Comparing the pool hierarchies for agreement versus task-oriented groups illustrates the potential for prerequisite pools to differ by context. We emphasize that there are many, many more pools possible, even in these relatively simple contexts. Indeed, it is probably not possible to identify all of the pools that might be desired by interactants, because as an encounter proceeds, one might suddenly get the urge to become aware of something that is ostensibly unrelated to the task at hand, but that might have relevance to a relationship (e.g., how many children another has, or what they are doing the next weekend). The pool hierarchy may also be extended as the encounter proceeds. For example, one group member may wait to build awareness about whether another is appropriately assigned to a role in a task-oriented group until after one had learned whether the other had a preference toward performing the role and whether the activity itself had a purpose toward the groups' goals, in addition to the pools noted earlier.

Thus, we suggest that while providing lists of typical pools of awareness in various contexts is certainly useful to technology designers, it should not be seen as an end in itself, because users may have other matters to which they wish to attend.

> *Proposition 6: Awareness needs are highly context-dependent. In essence, the selection of pools that need to be filled is different across contexts.*

We have suggested that pools are not filled all at the same time; specifically, that some pools are prerequisites for others and thus filled early in an encounter, while others are filled later in an encounter. Drawing on this implicit notion of a hierarchy of pools, we further suggest that higher-level pools are *shallow* in the sense that they are easier to fill, but also drain much faster than lower-level pools. For example, while awareness of how many people are in a mediated environment (e.g. a chat room) can be established quite quickly, awareness of another's preferences, political views, and/or organizational status takes much longer to be created. However, being more profound (i.e., deeper), these aspects of awareness are also much more stable. Hence, while awareness that is encounter-specific drains quickly, awareness that is relationship-specific is much more lasting and can be drawn upon even after months of not interacting. The latter (relationship-specific) information is relatively long-lived in mediated communication when compared with the fundamental pools of presence, identity, and activity. Such fundamental aspects need some replenishment at the initiation of each new encounter. We offer two simple examples that illustrate the need to replenish fundamental awareness pools. (1) One may have uncertainty about when another will be available to read and reply to an important e-mail, and may request that the other reply immediately to indicate that it has been received. (2) One may have uncertainty about whether another is available for a voice call via Skype, and may request such information via an e-mail or a chat message (even if the other's status flag shows that they are online).

> *Proposition 7: Fundamental types of awareness are more encounter-dependent and are developed quicker. In addition, the stores of more fundamental types of awareness also decline much more rapidly than other types of awareness, which are of personal or relationship information. In essence, higher-level pools in a hierarchy fill faster, but must*

be replenished with each encounter, while lower-level pools are filled much later, but retain their levels for longer.

In this section we firstly proposed a dynamic conceptualization of awareness, which conceives awareness as pools located within people that fill gradually over time and which also drain when not being maintained. Three propositions explain the pool notion of awareness, while the next four propositions elaborate on the relationships between pools: awareness needs (pools) in a social encounter form a hierarchy of dependencies, with the actual selection of pools being context-dependent, while three needs (presence, activity and identity) are seen as universal. Also, higher-level pools in the hierarchy are encounter-dependent and shallow, in that they fill and drain quickly, while lower-level pools are seen as relationship-dependent and deeper, in that they take more time to fill, but will last longer. Having explained the nature of awareness and the context-dependency of awareness needs, we will now turn to explaining the mechanisms of awareness creation as captured in the streams notion.

Directing the Streams: A Practice-based notion of awareness creation

In contrast to the technology-centric view, we argue that it is the interactants in a specific situation that create awareness through their communication and shared work practices, and that awareness is not simply provided by technology. As such, awareness is the result of shared, mutual practices of signaling and observing. People signal awareness information to others and likewise perceive what others are signaling. We conceive of these signals, created by the interactants, as streams of awareness information. Awareness emerges as people fill their pools of awareness by drawing on the available streams (i.e., by observing the signals that are carried by the technology).

Furthermore, we suggest that one's interaction is guided by a view of the generalized other. Hence, the signals one sends are determined by two considerations: one wishes to fill specific awareness pools, and one recognizes that others wish to fill similar pools. Thus, awareness is based on the concept of projection; as one engages in signaling, conveying certain aspects of

awareness, one projects one's own 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). Hence, the kinds of awareness streams that are created are dependent on the ways in which interactants perceive each other.

Ultimately, signaling and observing can be seen as two sides of the same coin in the creation of awareness; they form a duality with both concepts relying on each other, as the observing of information and activities that are relevant for one person requires that information to be displayed by others.

> *Proposition 8: Awareness results from mutual practices of signaling awareness information and observing this information.*
>
>> *Proposition 8a: Awareness information is conveyed through social signaling practices. In essence, the streams, which convey awareness information, are initiated/created by interactants.*
>>
>> *Proposition 8b: Awareness emerges when awareness information is observed and used by interactants. In essence, the pools within interactants fill as a result of capturing the awareness information flowing from the streams.*

The streams metaphor is also important because it emphasizes that the signals that move among interactants can be directed deliberately to fill certain pools. Considering that one has goals for an interaction, these goals influence what he/she attends and what they wish to be attended to. For example, consider the member of a group that is thrust into a chat room and told to determine whether a course of action is ethical or unethical. First, he/she must be assured that his/her comments will be attended to. This assurance might come externally (i.e., from a face-to-face interaction) or when he/she sees the comments of another appear on their screen. Once the presence of others has been determined, he/she will shape the interaction according to what he/she feel is important and his/her perceptions of what others feel is important. Thus, the streams may be directed toward personally identifying others, achieving an affective relationship with others, or simply to aspects of their task. This understanding of interactants deliberately directing the streams to fill certain pools complements the notion of the hierarchy of pools (proposition 5) and the context-specificity of awareness needs (proposition 6).

Proposition 9: Interactants deliberately attend to certain types of awareness before others. In essence, awareness streams are directed by the interactants in both signaling and observing in order to fill certain pools before others.

Awareness as portrayed so far is not a feature of technology, but the result of shared practices in which the technology becomes embedded. "Essentially, 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, 13) However, technology plays an unquestionably vital role in the process of awareness creation by enabling and also constraining social practices: while technology cannot *per se* produce awareness, specific technological features enable (or constrain) the creation of awareness. Furthermore, such features still have to be appropriated by interactants; meaning that signals ostensibly produced by the technology are actually under the control of the interactants and may be observed in unintended ways (e.g., the modification of IM screen names to display status information (Smale and Greenberg, 2005). Hence, while awareness is created through practice the technology acts as an enabler; communication technology is the medium that carries the streams of awareness information and as such enables the practices to emerge.

Proposition 10: Technology plays a vital role in awareness creation as it acts as a medium and enabler. In essence, the streams are carried by technology.

We also recognize that by shifting attention to a particular aspect of awareness as they interact, participants in an interaction fill that particular pool at a faster rate than others. Hence, we argue that streams have volume. This volume is to a considerable extent determined by the nature and characteristics of the communication medium. Noting that a stream of communication has both volume and particular content, increasing the overall volume of interaction (e.g., using voice communication rather than text (Walther, 1992)), is likely to mean more rapidly accumulating pools of awareness over a given time. 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 kinds of signals they are capable of transmitting, with some media providing richer or wider channels. We argue that richer channels are likely to

convey multiple aspects of awareness, meaning that interactants can direct the streams of awareness toward filling pools more rapidly or even multiple pools simultaneously. At the same time, because mediated communication channels are often quite limited in the amount of information that can be conveyed, interactants must choose what information to communicate, and recognize that others are similarly able to choose.

> *Proposition 11: Interactants can influence the speed of awareness creation, especially by selecting certain media over others. In essence, streams have volume (the rate with which pools fill), which is limited by the characteristics of the medium.*

Finally, with regard to practices of signaling and observing, two levels of engagement can be distinguished: active and latent. Active signaling refers to the user deliberately conveying certain information in order to fill a particular pool of awareness (i.e., feeding and directing a certain stream). In our thought experiment, with the statement "This is Pat", the user actively signals identity. On the other hand, signaling can also be latent, meaning signals are often conveyed as a by-product of other activities. For example, the pools *reliability* and *skill* might be filled as a by-product of users behaving in a corresponding way during the course of the interaction. Rather than having to actively communicate skill the respective signals are picked up by others as the result of the user carrying out a task that requires a particular skill.

Furthermore, we recognize that awareness tools can help filling a particular pool even if the participants do not focus their attention on that particular dimension. For example, instant messaging tools provide status features in their interfaces for providing presence awareness; providing additional information about presence that would ordinarily require an exchange of signals (e.g., available, off line, do not disturb, etc.). This means one can initiate an awareness stream by allowing the technology to convey these presence-related signals, without having to actively attend to feeding this stream later while the stream continues to be delivered by the technology. And finally, on certain occasions, entirely new streams of awareness might spring up involuntarily as by-product of the practice one is engaged in during that particular encounter. An example would be the colleague who enters one's office (as part of a work practice) while one is

engaged in a phone conversation with another and thereby conveys certain personal information to others on the other end of the phone line.

In the same way as signaling, observing can also be active and conscious, in the sense of paying attention, or be rather latent or peripheral, in the sense of being an implicit part of other activities. On the one hand one might actively monitor the signals coming from others, as when one actively observes who is online in the contact list of IM. Hence, one can actively direct streams provided by others to fill one's pools of awareness. On the other hand, while observing the stream of communication related to one particular pool of awareness, one might at the same time observe information about others that is only peripherally relevant to an overall goal of the interaction, but is nevertheless added to an awareness pool (i.e., "filed away"). Observing can thus be rather implicit, almost like noticing the light or noises coming from a colleague's office in passing. In this case, awareness pools are filled with relatively little observational effort.

Consequently, we conclude that both signaling and observing can be, but need not be the result of deliberate user action, rather awareness can arise almost subconsciously as the by-product of other activities or be a part of general communication (e.g. while one is talking on the phone, background noise might provide a notion of the other's physical presence and location).

> *Proposition 12: Both signaling and observation of awareness information can happen either actively or as by-product of other practices.*
>
>> *Proposition 12a: Awareness information can be actively provided through communication or be conveyed as by-product of other practices. In essence, while some streams are deliberately created and fed, others spring up unintentionally and/or continue to be delivered by technology.*
>>
>> *Proposition 12b: Awareness information can be actively sought by monitoring the virtual workspace or be perceived in the form of peripheral information while being engaged in other activities. In essence, interactants can actively direct streams to fill their pools, while other pools can be filled without effort.*

Discussion

In the preceding sections, we introduced a theory that describes a dynamic notion of awareness and explains why and how awareness is created via mediated communication. Our theory is somewhat general in that the pools and streams notion could be applied to all forms of communication. For example, uncertainty reduction theory (URT) suggests that uncertainty in face-to-face encounters is particularly salient in "the initial stages of interaction between strangers" (Berger and Calabrese, 1975, 110), and similar to our notion that pools of awareness drain over time, URT suggests that "persons who do not have frequent contact with each other become uncertain about each other" (p. 110). However, we feel that our pools and streams theory identifies issues about obtaining and maintaining awareness that are uniquely suited to research and design in *mediated* contexts, because fundamental awareness needs recur with each encounter, while these needs are taken for granted in face-to-face encounters. Our framework builds from the notion that one needs to reduce uncertainty when communicating, but we emphasize the need to understand which uncertainty needs occur when one uses a new mediated communication tool, and which uncertainty needs will recur after interaction ceases for a time. Correspondingly, in our theory, the pools of awareness represent uncertainty needs. In the following, we will discuss implications of our theory for mediated communication researchers and then for tool designers in practice.

Implications for Researchers

Most studies in the CSCW and HCI domains have treated awareness as a design problem: tools need to be built in certain ways in order to enable awareness. Gross and colleagues 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; also, "novel behaviors might be recognized that lead, in turn, to novel features, and so forth" (Gross et al., 2005, 356). In the information systems domain, historically, mediated communication research has argued from a similar technology

determinist position and hence been 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), while later research suggested that mediated communication was appropriate and even encouraged informal communication (Walther, 1995), and was employed by managers for equivocal communication tasks (Markus, 1994). 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).

However, a technology determinist position, which expects certain awareness effects as a direct consequence from applying communication media in context, as well as a design-oriented view, which treats awareness as the outcome of designing and providing certain feature combinations, both fail to account for the agency of users and their inventiveness and creativity in creating awareness from communication and from using tools in unexpected ways. In this respect, designing sophisticated awareness technology might actually turn out to be too restrictive; such technologies might not fit the particular context and also the need for awareness in context might change over time. As Heath et al. state: "…solutions which attempt to specify the width and focus of awareness a priori are unlikely to support even the most simple forms of collaborative activity." (2002, 345)

While researchers have recognized the fundamental needs for presence, identity, and activity awareness (Haines and Cooper, Forthcoming), when designing tools to support these needs, however, these researchers assumed that technology tools would provide those needs without recognizing that users must actively participate in awareness creation. Accepting the technology-based view of awareness without acknowledging user practices could lead to user frustration when technology "adapts" to the evolution of a group and leaves the group without a previously

taken for granted tool (Oemig and Gross, 2007), and lead to unexpected effects when the users do not adopt the tool as part of their communication practices (Haines and Cooper, Forthcoming).

Against this backdrop, we offer our theory as a means to guide future research on designing and applying technology to support awareness creation in context. For example, we suggest to further investigate the potential and use of flexible communication tools that allow and enable multiple ways of awareness creation instead of trying to build into tools elaborate forms of pre-specified awareness features. In this context, Information Systems as a discipline can make a substantial contribution, due to its focus on the interplay between the technical and the social aspects in organizational contexts. We offer some starting points for future research.

Exploring the context-specificity of awareness pools

Our theory proposes that awareness needs in mediated communication take the form of a hierarchy of inter-dependent pools that vary across contexts. As a natural first step, researchers might draw upon our framework in exploring the kinds of awareness needs prevalent in different organizational contexts. Based on our framework research can then derive specific hypotheses as to the different pools likely to play a role in a given context, as well as to their position within the hierarchy. In the following paragraphs we offer as a first starting point additional pools and prerequisites that are suggested by the results of prior mediated communication research. Many of these pools were not included in Figures 3 or 4 because they do not appear to be fundamental to either agreement or task-oriented groups.

We noted earlier that *preference* is awareness of what the others in the shared space want, and appears to fill after identity (i.e., if there is a need to know others' preferences, one will first wish to differentiate among different people in the shared space) (Haines et al., 2006, McLeod, 2000). *Availability* is awareness of when a particular person will be available to accomplish a task or engage in interaction, and appears to fill after activity and identity (i.e., if there is a need to know others' availability, one will first wish to differentiate among people and be able to predict what

activities will occur) (Steinfield et al., 1999). *Similarity/Depth* is awareness of the values of others and appears to fill after identity (i.e., before one will desire information about the values of others, one will wish to differentiate among others in the shared space) (Lea et al., 2001, Walther, 1995). *Influence* is an awareness of the salience of another's preference, which appears to fill after preference and similarity/depth (i.e., if there is a need to know whether one should be influenced by others' preferences, one will wish to differentiate among different people and also to be able to determine whether those others share similar values or are opinion leaders) (Sassenberg and Postmes, 2002).

More pools and prerequisites are suggested by looking more broadly at the group process and performance research. *Location* is an awareness of where an activity is occurring or will occur and appears to fill after activity (i.e., if one needs to know where particular activities will occur, one will first wish to know what activities might occur) (cf., Gutwin and Greenberg, 2002). *Purpose* is an awareness of the reason for an activity and appears to fill after activity (i.e., if one needs to know why an activity is occurring, one will wish to know what activities are occurring or might occur) (cf., Gutwin and Greenberg, 2002). *Skill* is awareness of another's ability to perform an activity, and appears to fill after identity and activity (i.e., before one will desire to know the skills of others, one will wish to know the identities of those in the shared space and the activities to be performed) (Goffman, 1961). *Role* is an awareness of another's expected performance of an activity and appears to also fill after identity and activity (Goffman, 1961). *Cognitive trust* is an awareness that another can or cannot be relied upon to complete a particular task, and appears to fill after knowing another's skills and their reliability (McAllister, 1995). *Direction* is an awareness of the direction/context that the group is working in (i.e., what goals is the group moving toward), which arises after knowing the location and purpose of activities (Parks and Sanna, 1999, Steiner, 1972). *Affective Trust* is an awareness that another is caring and emotionally trustworthy (McAllister, 1995), which arises after knowing another's role and their affiliation. *Responsibility* is an awareness of which person bears the responsibility for performing

a specific activity and arises after knowing another's role and purpose for a particular activity. *Coordination* is an awareness of the location where a particular activity will be performed, the skill of the person who is performing it, and the relationship with other activities in the work environment.

To illustrate the applicability of our theory with regard to awareness needs, we offer some testable hypotheses based on the pools introduced before. (1) Roles take longer to develop in virtual teams when team members communicate less information about their presence, activity, and identity (Sarker and Sahay, 2003). (2) Trust takes longer to develop in virtual teams if team members communicate less information about their presence, skills, and reliability (Jarvenpaa and Leidner, 1999). (3) Group influence is higher via anonymous CMC if more information about identity, preference, and affiliation are communicated (Haines et al., 2006, Postmes et al., 1998, Spears and Lea, 1992). (4) Free riding in a GDSS brainstorming context is increased as presence and activity are communicated, and decreased as role and identity are communicated (Connolly et al., 1990). (5) Evaluation apprehension via CMC is increased as identity and affiliation are increased (Dubrovsky et al., 1991, Weisband, 1994). (5) Self-disclosure in on-line contexts is increased if awareness of others' presence is reduced (i.e., low public self awareness), and if awareness of one's own activities are increased (i.e., high private self-awareness) (Joinson, 2001).

Exploring the dynamic nature of awareness over time

While awareness researchers have begun to recognize the evolving nature of awareness needs over time (Oemig and Gross, 2007), the dynamic notion of awareness as proposed in our theory remains largely under-researched so far. Future research should explore how awareness needs 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 framework accounts for the evolution of awareness needs and the ability of users to

direct technology to fulfill those needs. In essence, we recognize that communication technology is the tool that carries the streams that users direct toward different pools of awareness.

More specifically, researchers might turn not only to identifying the different needs over time, i.e. the changing of the pool hierarchy, but also to exploring the extent to which certain pools in the hierarchy have to be filled in specific encounters of a social group. Our theory proposes that awareness develops gradually from very basic notions, e.g. the mere being-there of others, to very elaborate understanding of aspects of others, e.g. their physical, bodily presence. While our theory captures this understanding, we still know little about the depth of certain pools as well as their different stages of filling in a concrete context or how these might be conceptualized (e.g. can we identify scales that describes the filling of certain pools?). A typical research questions in context might be: How much filling of which types of pools do people need, in a given context, to be able to work effectively?

Exploring the practices of awareness creation

So far, we have arrived at an appreciation for the necessity to view awareness as resulting from practice and at a conceptualization of the mechanisms of awareness creation, as manifested in our stream-related propositions above. However, more research is needed to better understand the proliferation of shared practices in social contexts. In doing so, future research should also aim at understanding why some tools appear to be better than others at facilitating or enabling practices of awareness creation (Riemer et al., 2007).

In our theory we have elaborated on the fundamental mechanisms that breed awareness, i.e. the signaling and observing as the two main activities of awareness practices. Future research should aim at contextualizing these mechanisms in that it explores the nature of concrete practices and the nature of observing and signaling in given organizational contexts. For example: Is signaling more conscious/active or a peripheral part of other practices? What technologies are drawn upon to carry the streams of signaling information? What role do tools play in feeding certain streams automatically, without user involvement? Is signaling done in a more bilateral, idiosyncratic

manner, or does it happen on a group-level? Are people aware of the draining of pools and do they adapt their practices accordingly?

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. Obviously, ethnographic studies and workplace observations are very well suited to gain an understanding of how people draw on and use ICT in their practices of distributed work and awareness creation (Riemer et al., 2007). As for the exploration of the micro-structure of awareness creation activities, i.e. the signaling and observing of awareness creation through communication, experimental setups might be best able to control for group-level and technology-level influence factors on the proliferation of such practices .

Implications for Tool Designers

The simplest advice to practitioners derived from our framework is that technology tools should be designed to support users in filling the highest-level pools first: presence, identity, and activity. Other awareness researchers offer similar advice (Gross et al., 2005, Gutwin and Greenberg, 2002, Jang et al., 2000); however, using the streams and pools metaphor, we offer a sense of why those elements of awareness are so critical: by turning the stream to presence, identity, and activity (in some cases before any other interaction occurs), these tool designs allow users to immediately focus their interaction stream on other aspects of awareness. These "downstream" aspects of awareness are more context-specific and may likewise be more critical for the groups in getting organized and accomplishing their specific tasks (Haines and Scamell, 2003). As interaction proceeds, the more fundamental aspects of awareness may be taken for granted, meaning that technology that provides this awareness may be ignored. However, we have noted that these fundamental awareness needs are likely to recur quickly if interaction ceases.

Other work in context-based awareness technology has similarly recognized that awareness needs of interactants change over time. For example, it has been noted that when instant

messaging, one typically needs online status (i.e., presence) information about another only before a conversation is initiated: presence can be taken for granted as the interaction proceeds (Oemig and Gross, 2007). Similarly, the process of group development suggests that different aspects of awareness will be important in groups as they continue to work together over a longer period of time (Oemig and Gross, 2007, Sarker and Sahay, 2003). However, while our pools and streams framework allows for the continuous evolution of information needs, we again note the potential for information needs to devolve as the pools drain. In essence, a particular technology tool may be perceived of as useful before interaction begins, later to become disused, and finally to return to usefulness as the awareness needs of the interactants evolve. Potential reasons for awareness needs to change (i.e., evolve or devolve) include: group development over time (Haines and Scamell, 2003, Oemig and Gross, 2007), changes in existing member location (Riemer et al., 2007), new or leaving group members (Jarvenpaa et al., 1998, Sarker and Sahay, 2003), and changes in user practices with respect to the technology (Riemer et al., 2007). Thus, we believe that tool designers and researchers must recognize the potential for awareness needs to evolve, but should explicitly account for a user's desire to direct the interaction stream among awareness pools according to their needs and their perceptions of the needs of others.

Conclusions

In summary, we conceive of awareness in mediated communication as building in pools that are fed by directing streams of interaction. The interaction streams emerge from the actions of those involved in the interaction; specifically, we propose that interaction via mediated communication is directed by the interactants according to their need to fill various pools of awareness. By introducing this notion of awareness and by providing our framework and a set of propositions we hope to propose a useful theory of awareness creation that builds upon a dynamic notion of awareness creation and in doing so acknowledges the active role of the user (i.e. human agency) and the role of social practice in meeting awareness needs. With our work we contribute to ongoing research on computer-mediated communication and awareness in distributed work; we

argue that in order to advance our knowledge in this domain we are in need of a distinct Information Systems perspective, which treats awareness creation as social practice and moves beyond a mere technology view.

References

Berger, C. R. and R. J. Calabrese (1975) "Some Explorations in Initial Interaction and Beyond: Toward a Developmental Theory of Interpersonal Communication," *Human Communication Research* (1) 2, pp. 99-112.

Borning, A. and M. Travers. (1991) "Two Approaches to Casual Interaction over Computer and Video Networks." *Proceedings of the SIGCHI conference on Human factors in computing systems, New Orleans, Louisiana, United States, 1991*, pp. 13-19.

Boyer, D. G., M. J. Handel, and J. D. Herbsleb (1998) "Virtual Community Presence Awareness," *SIGGROUP Bulletin* (19) 3, pp. 11-14.

Cameron, A. F. and J. Webster (2005) "Unintended consequences of emerging communication technologies: Instant Messaging in the workplace," *Computers in Human Behavior* (21pp. 85-103.

Carmona, J. (2008) "Consequences of IM on Presence Awareness and Interruptions," in N. Kock (Ed.) *Encyclopedia of E-Collaboration*: Information Science Reference, pp. 102-106.

Connolly, T., L. M. Jessup, and J. S. Valacich (1990) "Effects of Anonymity and Evaluative Tone on Idea Generation in Computer-Mediated Groups," *Management Science* (36) 6, pp. 689-703.

Daft, R. L. and R. H. Lengel (1984) "Information Richness. A New Approach to Managerial Behavior and Organization Design," *Research in Organizational Behavior* (6pp. 191-233.

DeSanctis, G. and M. S. Poole (1994) "Capturing the Complexity in Advanced Technology Use: Adaptive Structuration Theory," *Organization Science* (5) 2, pp. 121-147.

DeSanctis, G. L. and B. Gallupe (1987) "A Foundation for the Study of Group Support Systems," *Management Science* (33) 5, pp. 589-609.

Dourish, P. and V. Bellotti. (1992) "Awareness and Coordination in Shared Workspaces." *Proceedings of the 1992 ACM conference on Computer-supported cooperative work, Toronto, Ontario, Canada, 1992*, pp. 107-114.

Dourish, P. and S. Bly. (1992) "Portholes: supporting awareness in a distributed work group." *CHI '92, Monterey, California, 3-7 May, 1992*.

Dubrovsky, V. J., S. Kiesler, and B. N. Sethna (1991) "The Equalization Phenomenon: Status Effects in Computer-Mediated and Face-to-Face Decision-Making Groups," *Human-Computer Interaction* (6) 2, pp. 119-146.

Frößler, F. (2006) "Communication Genres for Dispersed Collaboration: Towards an Understanding of Presence and Awareness." *Proceedings of the Twenty-Seventh International Conference on Information Systems, 2006*, pp. 1401-1414.

Giddens, A. (1984) *The Constitution of Society*, 9 edition. Cambridge: Polity Press.

Goffman, E. (1961) "Fun in Games," in *Encounters*, Indianapolis, Indiana: Bobbs-Merrill, pp. 15-81.

Gregor, S. (2006) "The Nature of Theory in Information Systems," *MIS Quarterly* (30) 3, pp. 611-642.

Gross, T. and M. Specht. (2001) "Awareness in Context-Aware Information Systems." *Mensch & Computer 2001: 1. Fachübergreifende Konferenz., 2001*, pp. 173-181.

Gross, T., C. Stary, and A. Totter (2005) "User-Centered Awareness in Computer-Supported Cooperative Work-Systems: Structured Embedding of Findings from Social Sciences," *International Journal of Human-Computer Interaction* (18) 3, pp. 323-360.

Gutwin, C. and S. Greenberg. (1996) "Workspace Awareness for Groupware." *CHI 96, Vancouver, Canada, 1996*, pp. 208-209.

Gutwin, C. and S. Greenberg (2002) "A Descriptive Framework of Workspace Awareness for Real-Time Groupware," *Computer Supported Cooperative Work* (11) 4, pp. 411-446.

Gutwin, C., S. Greenberg, and M. Roseman. (1996) "Supporting Awareness of Others in Groupware." *CHI 96, Vancouver, Canada, 1996*, pp. 205.

Haines, R., L. Cao, and D. Haines. (2006) "Participation and Persuasion via Computer-Mediated Communication: Anonymous versus Identified Comments." *Proceedings of the Twenty-Seventh International Conference on Information Systems, 2006*.

Haines, R. and R. Scamell. (2003) "The Development of Trust in Virtual Teams." *Ninth Americas Conference on Information Systems, 2003*.

Hayne, S. C., C. E. Pollard, and R. E. Rice (2003) "Identification of Comment Authorship in Anonymous Group Support Systems," *Journal of Management Information Systems* (20) 1, pp. 301-329.

Heath, C., M. S. Svensson, J. Hindmarsh, P. Luff et al. (2002) "Configuring Awareness," *Computer Supported Cooperative Work* (11) 4, pp. 317-347.

Herbsleb, J. D., D. L. Atkins, D. G. Boyer, M. Handel et al. (2002) "Introducing Instant Messaging and Chat in the Workplace," *chi letters* (4) 1, pp. 171-178.

Huysman, M., C. Steinfield, C.-Y. Jang, K. David et al. (2003) "Virtual Teams and the Appropriation of Communication Technology: Exploring the Concept of Media Stickiness," *Computer Supported Cooperative Work* (12) 4, pp. 411-436.

Jang, C. Y., C. Steinfield, and B. Pfaff (2000) "Supporting Awareness among Virtual Teams in a Web-Based Collaborative System: The TeamSCOPE System," *ACM SIGGROUP Bulletin* (21) 3, pp. 28-34.

Jarvenpaa, S. L., K. Knoll, and D. E. Leidner (1998) "Is Anybody Out There? Antecedents of Trust in Global Virtual Teams," *Journal of Management Information Systems* (14) 4, pp. 9-64.

Jarvenpaa, S. L. and D. E. Leidner (1999) "Communication and Trust in Global Virtual Teams," *Organization Science* (10) 6, pp. 791-815.

Joinson, A. N. (2001) "Self-Disclosure in Computer-Mediated Communication: The Role of Self-Awareness and Visual Anonymity," *European Journal of Social Psychology* (31) 2, pp. 177-192.

Koch, M. (2005) "Supporting Community Awareness with public Shared Displays." *18th Bled eConference, Bled, Slovenia, June 6-8, 2005*.

Lea, M., R. Spears, and D. de Groot (2001) "Knowing Me, Knowing You: Anonymity Effects on Social Identity Processes Within Groups," *Personality and Social Psychology Bulletin* (27) 5, pp. 526-537.

Leinonen, P., S. Järvelä, and P. Häkkinen (2005) "Conceptualizing the Awareness of Collaboration: A Qualitative Study of a Global Virtual Team," *Computer Supported Cooperative Work* (14) 4, pp. 301-322.

Ljungstrand, P. and Y. H. Segerstad (2000) "Awareness of Presence, Instant Messaging and WebWho," *SIGGROUP Bulletin* (21) 3, pp. 21-27.

Luo, X. and Q. Liao (2008) "Using IM to Improve E-Collaboration in Organizations," in N. Kock (Ed.) *Encyclopedia of E-Collaboration*: Information Science Reference, pp. 680-685.

Mark, G. (2002) "Conventions and Commitments in Distributed CSCS Groups," *Computer Supported Cooperative Work* (11) 3-4, pp. 349-387.

Markus, M. L. (1994) "Electronic Mail as the Medium of Managerial Choice," *Organization Science* (5) 4, pp. 502-527.

McAllister, D. J. (1995) "Affect- and Cognition-Based Trust as Foundations for Interpersonal Cooperation in Organizations," *Academy of Management Journal* (38) 1, pp. 24-59.

McLeod, P. L. (2000) "Anonymity and Consensus in Computer-Supported Group Decision Making," *Research on Managing Groups and Teams* (3pp. 175-204.

Mead, G. H. (1934) "Play, the Game, and the Generalized Other," in C. W. Morris (Ed.) *Mind Self and Society from the Standpoint of a Social Behaviorist*, Chicago, Illinois: University of Chicago, pp. 152-164.

Moore, R. J., N. Ducheneaut, and E. Nickell (2007) "Doing Virtually Nothing: Awareness and Accountability in Massively Multiplayer Online Worlds," *Computer Supported Cooperative Work* (16) 3, pp. 265-305.

Oemig, C. and T. Gross. (2007) "Shifts in Significance: How Group Dynamics Improves Group Awareness." *Mensch & Computer 2007: 7. Fachübergreifende Konferenz fuer interaktive und kooperative Menien, 2007*.

Parks, C. D. and L. J. Sanna (1999) *Group Performance and Interaction*. Boulder, CO: Westview Press.

Poe, E. A. (2003) "The Pit and the Pendulum," in *Tales of Mystery and Imagination*.

Postmes, T., R. Spears, and M. Lea (1998) "Breaching or Building Social Boundaries: SIDE-Effects of Computer-mediated Communication," *Communication Research* (25) 6, pp. 689-715.

Rennecker, J. (2005) "Promoting Awareness in Distributed Mobile Organizations: A cultural and technological challenge." *GROUP'05, Sanibel, Florida, USA, November 6-9, 2005*.

Rice, R. E. (1993) "Media Appropriateness: Using Social Presence Theory to Compare Traditional and New Organizational Media," *Human Communication Research* (19) 4, pp. 451-484.

Riemer, K., S. Klein, and F. Flößler. (2007) "Towards a practice understanding of the creation of awareness in distributed work." *Proceedings of the Twenty-Eighth International Conference on Information Systems, 2007*.

Robertson, T. (2002) "The Public Availability of Actions and Artefacts," *Computer Supported Cooperative Work* (11) 3-4, pp. 299-316.

Sarker, S. and S. Sahay (2003) "Understanding Virtual Team Development: An Interpretive Study," *Journal of the Association for Information Systems* (4pp. 1-38.

Sassenberg, K. and T. Postmes (2002) "Cognitive and Strategic Processes in small groups: Effects of anonymity of the self and anonymity of the group on social influence," *British Journal of Social Psychology* (41pp. 463-480.

Schmidt, K. (2002) "The Problem with 'Awareness'," *Computer Supported Cooperative Work* (11) 3, pp. 285-298.

Scupelli, P., S. Kiesler, S. R. Fussell, and C. Chen. (2005) "Project View IM: A Tool for Juggling Multiple Projects and Teams." *CHI 2005, Portland, Oregon, USA, 2005*.

Short, J., E. Williams, and B. Christie (1976) *The Social Psychology of Telecommunications*. New York, NY: Jogn Wiley & Sons, Ltd.

Spears, R. and M. Lea (1992) "Social Influence and the Influence of the 'Social' in Computer-mediated Communication," in M. Lea (Ed.) *Contexts of Computer-Mediated Communication*, Hemel Hempstead: Harvester Wheatsheaf, pp. 30-65.

Steiner, I. D. (1972) *Group Process and Productivity*. New York: Academic Press.

Steinfield, C., C.-Y. Jang, and B. Pfaff. (1999) "Supporting virtual team collaboration: the TeamSCOPE system." *Proceedings of the international ACM SIGGROUP conference on Supporting group work, 1999*, pp. 81-90.

Walther, J. B. (1992) "Interpersonal effects in computer-mediated interaction," *Communication Research* (19) 1, pp. 52-90.

Walther, J. B. (1995) "Relational Aspects of Computer-Mediated Communication: Experimental Observations over Time," *Organization Science* (6) 2, pp. 186-203.

Weisband, S. (1994) "Overcoming Social Awareness in Computer-Supported Groups: Does Anonymity Really Help?," *Computer Supported Cooperative Work* (2) 4, pp. 285-297.