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From Spaces to Places: Emerging Contexts in Mobile Privacy

Clara Mancini*, Keerthi Thomas*, Yvonne Rogers*, Blaine A. Price*, Lukasz Jedrzejczyk*,
Arosha K. Bandara*, Adam N. Joinson†, Bashar Nuseibeh*

Department of Computing, The Open University, UK*

School of Management, University of Bath, UK†

C.Mancini; K.Thomas; Y.Rogers; B.A.Price; L.Jedrzejczyk; A.K.Bandara; B.Nuseibeh@open.ac.uk

A.Joinson@bath.ac.uk

ABSTRACT

Mobile privacy concerns are central to Ubicomp and yet remain poorly understood. We advocate a diversified approach, enabling the cross-interpretation of data from complementary methods. However, mobility imposes a number of limitations on the methods that can be effectively employed. We discuss how we addressed this problem in an empirical study of mobile social networking. We report on how, by combining a variation of experience sampling and contextual interviews, we have started focusing on a notion of *context* in relation to privacy, which is subjectively defined by emerging socio-cultural knowledge, functions, relations and rules. With reference to Gieryn's sociological work, we call this *place*, as opposed to a notion of context that is objectively defined by physical and factual elements, which we call *space*. We propose that the former better describes the context for mobile privacy.

Author Keywords

Mobile privacy, context, experience sampling, memory phrase, contextual interview, Facebook, place.

ACM Classification Keywords

D.2.1: Requirements: elicitation methods; J.4 Social and Behavioural Sciences: sociology; K.4.1: Public Policy Issues: privacy

General Terms

Experimentation, human factors, theory

INTRODUCTION

Research is beginning to investigate privacy in mobile computing. This includes: location-tracking and position-

aware services [1]; location disclosure [2]; privacy preferences and sharing patterns [3]; models for privacy protection [4]; and attitudes and behaviors [5].

However, privacy issues are sensitive, difficult to study and poorly understood. Survey methods such as questionnaires or standard interviews, commonly used in requirements elicitation, can gather large amounts of data quickly and cheaply, but provide only limited insight into what users really feel and need when it comes to privacy. Asking users what level of privacy they want on their mobile phones, for instance, would be like asking self-proclaimed healthy eaters if they prefer to snack on a piece of fruit or on a candy bar: everyone says they prefer fruit, but when it comes to actually choosing one or the other, many go for the candy bar [6]. Users may simply not know or be aware of how they really feel or what they really need until they find themselves in a real situation in which they experience and reflect on those feelings or in which those needs arise.

The challenges with studying mobile privacy

We propose that investigating mobile privacy requires a diversified approach, which allows for the cross-interpretation of data from complementary studies [7]. *Ideally* this should include the observation of users' spontaneous behavior and communication processes while they are taking place, or as they have taken place [8, 9], and should aim to gather different data sets from different communication channels so that they can be interpreted in counterpoint. In Ubicomp, direct observation is often combined with other qualitative methods (for instance, shadowing of and interviewing participants may be combined) [7]. However, when it comes to studying mobile privacy, there are several obstacles to the use of direct observation. In order to get meaningful data, the presence of the observing agent (human or machine) must go unnoticed by the participants of the study. If participants perceive the presence of the observing agent, they are very likely to react to what effectively constitutes an intrusion of privacy by altering their behavior. In the study of privacy in tethered technology [10], for instance, this obstacle could be overcome by setting up appropriate recording devices in

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a familiar environment (e.g., the home) in whose background these can eventually fade [11]. However, mobility makes this kind of solution impossible: any observing agent that was following the participants around would hardly go unnoticed and would therefore end up intruding into their privacy and altering their behavior. An alternative method is to observe the activity and interactions of unidentified mobile users in public spaces (e.g., a train, an airport, a town square, etc. [12]), although cross-interpreting the findings with those from, for instance, interviews with identified participants would be difficult.

This paper presents the approach we have taken to investigate mobile privacy in a *qualitative* exploratory study on mobile social networking. As reflected in its structure, its contribution is three faceted, each contribution being dependent on the others. Firstly, we describe the empirical method used, which combines a variation of experience sampling and what we call *deferred* contextual interviews. Secondly, we demonstrate how this method yielded new insights into an emerging notion of *context* defined by different types of socio-cultural boundaries. Thirdly, we frame this emerging notion of context using the dichotomy between *space* and *place*, that has been used in different disciplines [32, 34-36] to distinguish between two different notions of environment: the former defined by objective parameters such as geographical location, time, activities, agents, etc.; the latter defined by the subjective meaning that these acquire within the realm of socio-cultural functions, relationships and interactions. We propose that, because of its characteristics, the concept of *place* can be used more appropriately than others [13-16] to describe mobile privacy.

INVESTIGATING MOBILE PRIVACY: OLD METHODS, NEW USES

Experience sampling has been used in Ubicomp user studies to capture data about people's feelings and behaviors in daily life situations, at the time when these feelings and behaviors occur, in a non-intrusive way and over an extended period of time [10, 17]. Usually, this is done by giving or delivering a set of questions to the participants in the study, either on paper or electronically, automatically or manually, at regular intervals, or upon the occurrence of specific episodes. This method is used when it is impractical to use direct observation methods, such as for instance shadowing (in which an observer spends time with the participants in their own environment). This is precisely the case when studying mobile privacy: as mentioned above, in practice any direct observation methods result in a modification of what would otherwise be spontaneous behavior.

However, gathering meaningful data through experience sampling requires considerable commitment on the part of the participants, since they may have to spend a significant amount of time answering the experience sampling questions, possibly in circumstances that may or may not be convenient [18]. This becomes problematic when gathering

privacy-related data about the use of mobile devices, namely mobile phones. Devices such as mobile phones follow people more or less everywhere and, when relevant episodes occur, people may be in transit or engaged in activities that make them unable to spend time answering questions. Even if they were able and willing to do it, their activities would be disrupted, which is likely to affect their state of mind and behavior.

Therefore, when studying mobile privacy, an experience sampling questionnaire can only ask for a minimal amount of feedback making sure that it can be provided in the shortest possible time. However, in order to be useful, that feedback needs to be detailed, providing information about specific episodes and the contexts in which they take (or took) place [19]. In order to gather detailed and meaningful data based on specific real experiences we used a combination of experience sampling and semi-structured interviewing adapted for the study in question.

From experience sampling to memory triggering

The experience sampling questionnaire was delivered and answered via the same device that was being used to study mobile privacy: the mobile phone. The questions were designed to be simple, quick and easy to reply to, so that the participant could deal with them in a very short time. The electronic delivery of questions and recording of answers greatly speeded up the process, especially since participants were able to choose between predefined multiple-choice answers from a menu.

The purpose of asking simple questions that elicited simple predefined answers and therefore only provided a limited amount of information was to provide the interviewer with pointers or indexes into different aspects of particular events on which the participants provided feedback. This was done mainly to provide structure within a single interview and to ensure structural consistency across different interviews. During the course of the study, participants provided feedback on several events, often giving the same predefined answers to the same questions in relation to different events, and in many cases the interviewing took place a number of days after the occurrence of an event. Therefore, participants could not be expected to faithfully and exhaustively remember what their experience of each specific event had been like.

To allow the participants to do that, the interviewer used a trigger whose purpose was to allow them to go back to the memory of particular events and retrieve all relevant aspects of their experience in as much detail as possible. This was provided by the participants themselves and was elicited by adding at the end of the experience sampling questions a request for a *memory phrase*, which could refer to or describe anything that participants associated with each particular event they provided feedback on. The memory phrase was an equivalent of the *madeleine* for Marcel, the main protagonist of Proust's famous novel *Recherche du Temps Perdu* [20]: just as the madeleine

transports Marcel back into a world that is long gone but still vivid in his waking memory, so was the memory phrase intended to bring the memory of participants back to the events on which they provided feedback.

In other words, the memory phrase, as we intended it, is not simply a tag onto a memory in a memory archive, because it may have no semantic relation to the event to which it is associated. The association is determined by the experience of a particular event in the specific context within which that event took place, or rather within what participants subjectively perceive as constituting the context of that experience. Because participants themselves chose the phrase that they associate to an event, the phrase was capable of triggering a connection to the experience to which it was associated and to bring participants back to that context. While others have used experience sampling in combination with the use of pictures [10], we think it is particularly valuable to rely on the cognitive associations that lead people to choose a memory trigger without the constrictions and mediation of technological devices.

Deferred contextual interviews

Once participants had reconnected to those events, they were able to provide detailed information about their experience of them during interviews. The interviewer could remind participants of the memory phrase they had associated with a particular event and, as the participant went back to that *place*, the interviewer could use the experience sampling questions and answers as pointers to different aspects of their experience. This way, participants were able to retrieve far more information than the experience sampling questions could have possibly allowed them to record during the study. It was not important if the questions and any predefined multiple-choice answer were not specific or accurate enough, or even the 'right' ones: they were merely access points, for the interviewer, into the memory of an experience which was far richer and more complex than any experience sampling question could have possibly captured. In our study, it was the memory trigger that constituted the most important item of the experience sampling questionnaire.

Given the effectiveness of the memory phrase in bringing participants back to a particular experience and the context in which it took place, the interviewer could carry out what effectively constituted a *deferred* contextual interviews, which could extract detailed and specific information about the context in which certain actions had taken place.

A QUALITATIVE STUDY ON MOBILE PRIVACY: MOBILE FACEBOOK PRACTICES

Our research [21] is investigating privacy requirements for mobile computing technologies (i.e. potentially mobile devices designed to be carried around and used while in transit or in static places) with the aim of producing a reusable framework for privacy management with a number of demonstrator applications. Within the project we are carrying out both quantitative and qualitative research. The

qualitative research includes three different types of user study [22], respectively aimed to observe:

- how people deal with privacy issues as part of their daily practices when using networking services on their mobile phones;
- how people react when using mobile devices that can track their and others' location while offering no privacy protection;
- what emotional responses people have in relation to privacy issues when presented with mobile computing scenarios.

This paper focuses on the first type of study, called Mobile Facebook Practices, and discusses the results yielded by the approach described above.

Facebook has become the leading social networking application [23], offering functionalities that allow users to share both information and artifacts. Due to its wide-spread use, Facebook is also possibly the most studied networking application [24-27]. Existing studies, though, tend to focus on Facebook itself, whereas our focus is on mobile social networking in general and in particular on the privacy issues related to mobile social networking. Facebook only interests us in that it is a popular social networking application which is also mobile, thanks to mobile phones such as the iPhone, for which a specific Facebook application is available.

From the point of view of mobile privacy, the advantage of Facebook over other popular social networking mobile applications, such as Twitter, is that Facebook allows more varied activities and interactions and the content exchanged between users during these interactions. In other words, Facebook is a good example of the sort of virtual social environment in which or through which the complexity of mobile privacy issues is likely to manifest itself.

Focus of the study

To understand how people really feel about privacy, it is critical to understand how people's networking practices integrate with their daily life practices and routines (see [28] and [29]). In this study, we wanted to observe how Facebook activities integrate with people's other daily practices, in order to identify behavioral patterns, relevant to privacy concerns that may emerge when people deal with technology that is familiar to them. So, our aim was to observe, over a period of weeks, how, when and where people interact with their social networking service through their mobile phone.

Participants and devices

We monitored the Facebook activity of 6 participants. These were between the age of 21 and 28, either studying or working in two universities in the UK. All of them were experienced enthusiastic users of Facebook, who also used the networking application on their mobile phone. In order

to avoid inconsistencies, due to the different functionalities and user interface features of different phones, we selected participants who owned the same type of handset. Having investigated a number of handset models, we selected the iPhone, because it already had a Facebook application with a good user interface that supported a range of activities and interactions.

Method

We advertised the study through various mailing lists and by word of mouth, asking any volunteers to allow us to monitor their mobile Facebook activity, specifically any exchanges and interactions taking place between them and their Facebook friends over a period of three weeks. We also asked permission to interview them, at least one time during the course of the study and one time at the end of it. We also asked if we could spend some time with them during the course of the study, so that we could observe them in action. None of the volunteers were concerned by the idea of having their Facebook activities monitored or of being questioned about those. However, all the volunteers showed they were very uncomfortable with the idea of being accompanied around by a researcher even for just a few hours, and some of the volunteers who had previously come forward decided not to take part in the study as soon as they heard about our proposal to spend time with them (one candidate participant said she found the idea “spooky”, others said they found it “weird” or “strange”).

Moreover, accompanying participants hoping to observe their mobile networking activity would have been logistically difficult: people may use an application such as mobile Facebook at any time anywhere, and an observer might have to spend many hours with a participant before witnessing some activity, having to invade their privacy for a prolonged period of time. Therefore, we decided to gather data about participant’s mobile Facebook activity by combining two methods:

- an adaptation of the experience sampling method, whose purpose was to record some ‘structural’ information about those activities;
- in depth semi-structured *deferred* contextual interviews, whose purpose was to probe the participants, using the experience sampling data as pointers (the answers to the questions) and memory triggers (the memory phrase).

Experience sampling. For the former we devised a set of experience sampling questions for a number of Facebook actions: namely, adding a friend, updating the status, writing on someone’s wall, uploading a photo, uploading a tagged photo, commenting on an existing photo. The questions were the same for all actions and each of them had predefined multiple-choice answers for the participant to choose from. The answers to all the questions were the same for every action, except for the first question, some of whose answers (between one and three) were specific to each particular action. At the end of the questionnaire there

was a free-text field for participants to write a *memory phrase*. When the action was a ‘status update’, we used the text from the update as a memory phrase. This had exactly the same function, because: (1) a status update is usually a sentence written by the user; (2) it usually refers to what the user is doing, feeling or thinking (i.e. their context); and (3) in the case of our participant, on status update actions, their memory phrase very often provided the same information as the update. Each questionnaire took about 30 seconds to answer (as pilot tests showed).

1. Why did you do it now?	
a. Want my friends to know what I’m doing	
b. Want my friends to know what I’ve done	
c. Had a free moment now	
d. Felt comfortable here	f. Was bored
e. Felt like socializing	g. Other
2. Where are you?	
a. Work place	d. Private transport
b. Private place	e. Public transport
c. Public place	f. Other
3. What are you doing?	
a. Socializing	d. In a meeting/class
b. Enjoying leisure time	e. Waiting
c. Working	f. Other
4. Who are you with?	
a. Family	d. Colleagues
b. Friends	e. Strangers
c. Facebook friends	f. Alone
5. Have others seen your FB action?	
a. Yes	d. Probably not
b. No	e. Don’t know
c. Probably yes	
6. How do you feel about this?	
a. Comfortable	d. Displeased
b. Uncomfortable	e. Concerned
c. Pleased	f. Unconcerned
7. Memory phrase	
[empty text field]	

Table 1 – Questions and multiple-choice answers about the Facebook action ‘status update’, accessed by the participants via their iPhones.

As an example, Table 1 lists the questions and multiple-choice answers for the action ‘status update’:

- *Question 1* asked for information about the motivation for acting: answers (a) and (b) are specific to the action ‘status update’ and imply that the participants act primarily because they seek a connection with others through the networking application; answers (c) and (d) imply that they act primarily because the circumstances or their context allow it; answers (e) and (f) imply that the participants primarily act because of their inner state of the moment.
- *Questions 2, 3 and 4* tried to frame the ‘contingent’ context in which the participants find themselves at the time of acting: respectively location, activity and company.

- *Question 5* asked for information about the perceived level of privacy of the action taken and was only compulsory to answer if the participants' answer to the previous question was that they were not alone.

- *Question 6* asked for information about the emotional reaction of the participants in case their answer to the previous question was that their Facebook action had been seen, or probably seen by other.

As Table 1 shows, the answers to the questions did not provide any detailed information about the action or the context in which that took place; it is the memory phrase that provided an identifiable reference to a specific event. Participants knew that the purpose of the memory phrase was to help them remember the specific circumstances of their action and some of them made a rather creative use of it. For example, one of the participants did a status update during a rugby match that he was watching at home with his flat mates: the update was not about the match itself, but his chosen memory phrase for that action was "Hugh Grant". When questioned about it, he explained that he had been having a conversation with his flat mates about the film *Notting Hill*, in which the actor Hugh Grant plays the main character.

The memory phrase proved to be effective even when a considerable amount of time had passed between an episode and the interview: some interviews took place several weeks after the end of the study and, when reminded of the memory phrase, participants were able to recollect detailed information. On the other hand, they could not retrieve any details about the episodes for which they had not provided a memory phrase.

Implementation. To deliver the questions to the participants and collect their answers, we built a User Feedback System (UFS), whose aim was to collect data in an unobtrusive and practical way, via the participants' mobile phones. The system consisted of several modules, one of which collected Facebook status updates via the RSS feed at a sampling rate of 10 per hour. Another module, deployed on the same server, detected changes in the status of the Facebook user and sent an SMS message to the participant containing a URL to a web form containing a short questionnaire using their iPhone. If the status update was carried out through a desktop PC, the SMS would have been ignored by participants and no feedback would have been given.

Building the UFS presented us with a number of challenges. The first challenge was to detect status updates on Facebook and provide the user with a means to record their experience. This was not straightforward considering the fact that Facebook terms it as illegal to retrieve information from their servers directly through automated means including screen scraping. Creating a Facebook application for the sole purpose of collecting data (pre-authorized by the users) proved to be of little use because the Facebook Client on iPhone has no facility to trigger such applications.

We opted for using RSS feeds to poll for user data on a periodic basis, although only information about status updates could be gathered. To provide information on other mobile Facebook actions such as photo uploads, tagging, adding a friend etc. the user had to invoke a URL on the mobile phone and enter the additional information on the Facebook action that was performed, following which the appropriate questionnaire was displayed.

Interviews. Approximately a week into the study, the participants were interviewed. All interviews were audio-recorded. The shortest lasted 42 while the longest lasted 55 minutes. Interviews were all made of three parts:

- *questions about the person's habits and routines in daily life*; these included questions about, for instance, household arrangements, work patterns, socialization patterns, etc.; they aimed to develop a rough profile of the participant;

- *specific in-depth questions about the Facebook activity for which we had received feedback*; these followed the chronological order of the participants' Facebook actions and investigated further the answer they had provided to the experience sampling questions, including the choice of memory phrase; these questions aimed to probe the participants about their Facebook actions and gather further details about the context in which these had been carried out;

- *general questions about their use of Facebook and any privacy-related issue*; after going through their specific actions, these questions aimed to explore any issues that had not yet been touched on, expand on issues that had been touched on, and find out about the participant's general views on Facebook and privacy.

Although there was a structure to the interview, this was used flexibly in order allow the participants to discuss any emerging issues. The interviewer shared and discussed with the participant any interpretation of their answers.

Below are two examples of how (sections of) the interviews took place. The first example shows how, at the beginning of the discussion about an action, the memory phrase helped the participant to go back to the situation in which they carried out the Facebook actions. The second example shows how, when they did not provide a memory phrase, the participants were unable to recall the episode.

Episode 1

Interviewer: "*In the next action, you wrote on somebody's wall...do you remember what it was?*"

Participant E: "*Humm....*" [pause]

Interviewer: "*You put Bsod as a memory phrase*"

Participant E: "*Yes, it stands for blue screen of death.*"

Interviewer: "*What does that mean?*"

Participant E: "*In the morning, when my house mate told me that his computer had died, basically, and all it would*

show is a blue screen, and he wouldn't get past it...it happened about a month ago and it took him like four days to fix, so it happened again quite recently...so I came up here [at the university] for a meeting, like a group meeting, people I don't really know...and we had a free moment, so I just wrote on his wall...like, it sucks to be you...just messing around winding him up a bit..."

Interviewer: "So you said [in the ES answers] you did it because you had a quick moment..."

Participant E: "yes...I waited for the break...because I don't really know the people that well that are in the group..."

Interviewer: "So you didn't think that they saw you [in the ES answers]"

Participant E: "No...I sort of like, I was a bit sort of like, I kept it a bit more personal, sort of like held it close to my body...yes sort of like, sort of really not out there, they wouldn't really understand it..."

Interviewer: "What do you think would have happened if they had seen it?"

Participant E: "In my mind I thought they might have thought I was a bit harsh, a bit angry or a bit sadist, I don't know...but also it probably would raise quite a few questions, because I don't know then I don't want to answer too many questions on that sort of stuff, I just don't see the need, so I just decided to keep it a bit more personal..."

Episode 2

Interviewer: "The other [action] was a comment on a photo...you said [in the answers] that you had just recognized someone...do you remember?"

Participant R: "... hmmm ..."

Interviewer: "You said [in the answers] you were in a private place and you were working..."

Participant R: "Yes, I can remember what day it was, but I can't remember the photo..."

Interviewer: "You said [in the answers] you were alone and nobody saw you do that..."

Participant R: "Yes...hmmm...I can remember..."

Interviewer: "You said [in the answers] you came across this photo..."

Participant R: "...yes, it would have been a quick check..."

More extracts from the transcripts of the interviews are reported and categorized below to exemplify what emerged regarding issues of privacy and context.

Findings

Throughout the study, we received 65 responses in total via the UFS. 39 of these were about updating status, 8 about writing on someone else's wall, 6 about commenting on a

photo, 5 about adding a friend, 3 about uploading a photo, and 2 about uploading a tagged photo. Updating their status appears to be by far the action that participants carried out the most, with the great majority of participants answering that: they updated their status when they did because they wanted their friends to know what they were doing; they were in a private place; they were enjoying leisure time; they were alone; nobody saw their Facebook action; and they felt comfortable. The answers for all the other actions are much more evenly distributed and at first glance no particular patterns emerge.

However, these quantitative results are not intended to be meaningful in themselves, just as the purpose of the experience sampling questions was not to gather meaningful information, but to provide pointers into the memory of the participants' specific experiences with mobile Facebook, which were to be brought back to them by the use of the memory phrase. It is the memories of these experiences and the more general reflections that emerged during the deferred contextual interviews that produced the most interesting results.

For instance, the quantitative data about the status update seems to suggest that people update their Facebook status primarily to establish a connection with their friends, but at the same time they seem to do that in private when they are alone and are not seen by others. This suggests that the context for this kind of networking appears to be well defined. Moreover, while people are motivated to connect socially, they do so in spaces in which physical boundaries effectively keep them separated from those with whom they are not intending to connect.

Clearly there may be several reasons for why people would update their Facebook status in a private space when they are stationary: if they are at home, maybe they are alone and maybe they feel the need to connect with others in a virtual way; if they have company maybe they have no reason of resorting to virtual networking; if they are having leisure time maybe they have the mental space to think of socializing, etc. However, the data from the interviews shows that, at a certain level of abstraction, what happens is precisely that people network because they are motivated to connect with others but they also move within a complex system of boundaries [30, 31], which are socio-culturally motivated and reflect the social functions, roles, relationships and interactions that make up the context in which they act.

The qualitative findings of our study identify several kinds of boundary. The following participants' statements extracted from the interviews show how - while they arise in mobile contexts, due to the portability of the technology - none of these boundaries were motivated necessarily by physical factors, but rather by socio-cultural ones. The examples also show how these boundaries spontaneously emerge in specific socio-cultural contexts. Five ways of establishing boundaries were identified.

1. 'Personal policy' boundaries. These are the most stable type of boundaries we identified. They were set outright by participants who decided to use certain privacy settings or not to share certain information within Facebook because such information was considered private.

...usually I tend to be specific on a certain topic which I'm ok that people know...I'm not happy people knowing about my relationship...or my personal problems, my working problems...I usually don't put these... (Participant L)

...anything I feel is private to myself I keep it to myself. I have a lot of good friends so if I want to share it I am happy to share it with all my friends. If there was something private, that is more close to me, like a girl that I liked and I wanted to share it with a friend I would do that in person rather than on facebook... (Participant A)

...I was in the library...didn't know anybody...the only reason I would have to be concerned I if I was writing something private but I wouldn't write something private on my status...in my regards anything that go on my status is public so I shouldn't have a reason to be concerned about somebody behind me seeing what I am writing when 400 of my friends are going to see it directly...if it was something private I would write it in an email... (Participant G)

2. 'Inside knowledge' boundaries. These were set in communication contexts within Facebook amongst network members or between members and non-members. Participants seemed to use contextual knowledge to establish privileged, exclusive or private communication channels with individuals or groups. One participant relied on this exclusive sharing of knowledge to get a reaction from one specific member within their Facebook network. On the other hand, outsiders' lack of contextual knowledge is what made another participant feel safe against intrusions.

...there is a way if I want to target a specific person on specific things...if I want to have some support from particular people I tend to use that particular thing that relate to that person...that person reacts. If you go back to my status with Karis...I write down "Dario is missing Katan...it's basically a war game...and I am very close to Karis and her husband Chris and nobody else knows about that... Karis replies "I am missing that too and if you come in September we can play... (Participant L)

...there is a separation between what you want people to know. If I talk about going to a disco with my friends I don't necessarily want my parents to know, not because here is something wrong with it, but because it's not important to them. Equally my parents wouldn't have a hope of getting around either Facebook or Twitter, so I've got nothing to worry about... (Participant A)

3. 'Etiquette' boundaries. These seem to be set by spontaneously emerging codes of conduct in specific environments and appear to be respected by restraining one's behavior (e.g., by not looking at others or by

abstaining altogether from using Facebook) in order to make one's behavior socially acceptable. Participants thought they could rely upon these codes to protect their privacy within specific socio-cultural contexts but not in others. In some cases, the code of conduct of the insiders (e.g., those who update others' status or those who use Facebook during lectures or) seems to be different or in conflict with the code of conduct that one might expect outside of the Facebook community and the breach seems to express a privileged position inside the community (e.g., one's Facebook friends) or a judgment towards the outsiders (e.g., the lecturers).

...I am quite happy to do it in most situations, like at least to check...aside places where I wouldn't do it...not because I wouldn't feel comfortable doing it...would be like at family events, family meals and things like that, cause it's more rude, so it's more the people...yes, I wouldn't want to be rude...[with my friends] if something comes through I would be happy to take it...friends would be fine...when you are with friends it's more relaxed, whereas with family there is more of an inbuilt strictness...with my family, they don't understand the technology and don't see the point, they don't see the need...it's also especially with some members of the family, like the older ones, like a generation gap... (Participant D)

...if I am out with friends I don't take my phone out, I don't do Facebook...yes, ok, if I am with my sister I keep to read emails ... (Participant L)

...I think like in library setting there is an unwritten rule that you don't look at anyone else's Facebook...I don't know is like a kind of etiquette that you don't look at anyone's Facebook...it's impolite...on the bus you don't know who they are, it's less of an uncontrolled setting as opposed to everyone knowing the etiquette in the library...the public on a bus they might never have used Facebook before, they may not know the etiquette...the library is more controlled... (Participant D)

...I didn't actually post this one...this is one of my friends. I don't know how they got it [the phone]...probably when I looked away...It's kind of an ongoing joke, we update [each other's] statuses... (Participant A)

...I tend to check it a lot when I am in lectures. We were sat together, they were close [friends]. They probably didn't see it. You could see that they [also] were doing it...It is a sort of knowledge [that everyone does it]. I didn't mind, if they saw it, they wouldn't mind...probably, there is a chance definitely that the lecturer would see me...[I don't mind] if the lecture was more interesting I would pay attention... (Participant D)

4. 'Proxemic' boundaries. These were made necessary by the physical proximity of outsiders and were set by either positioning the handset in a way that would make it impossible for others to see the participants' Facebook exchange or by abstaining from exchanging altogether.

Participants seemed to want to keep their Facebook exchanges protected from the intrusion of outsiders because they thought that: 1) outsiders would not have the contextual knowledge (see above) to interpret the exchange and might misjudge them or get the wrong idea; 2) outsiders would intrude into the privacy of specific groups or individuals that ought to be protected; 3) outsiders invade one's private (physical and otherwise) space.

...I just wrote on his wall...winding him up a bit...it was more just a joke...we had a quick break during this meeting...I don't really know the people in the group...I sort of like, I was a bit sort of like, I kept it a bit more personal, sort of like held it close to my body, yes sort of like, sort of really not out there, they wouldn't really understand it...I thought they might have thought I was a bit harsh...I felt comfortable because they didn't see it. It was more an in-joke...also they don't know my mate, they don't know the back story...it probably come across differently if you don't know the back story... (Participant D)

...things like buses and trains I don't feel so comfortable, because, I don't know...lots of people I don't know...if they for example read some of the posts I have done...they don't know the people that they are aimed at or the back story...they'd probably come across quite differently and they would not understand them, it would look a little weird...[they would get] the wrong sort of almost the wrong first impression... (Participant D)

...I think if there is a stranger sitting next to me on the bus and he can see I would feel uncomfortable, I wouldn't want him to see because regardless of what I'm posting you know my friends messages they are still private and I wouldn't want a stranger to see them...I don't know I just think is a bit intrusive, it's like someone looking over your shoulders at a book you are reading... (Participant G)

...if people see the content I think it's not their business, I get a bit annoyed and frustrated and irritated...it my stuff, I don't want to share my stuff with you that I don't know...possibly you are too close to me, so you are invading my space... (Participant L)

5. 'Aggregation' boundaries. These were set across physical and Facebook social networks and the 'crossing' seemed to generate tensions between the two. That is, people who were included in one network seemed to expect to be included also in the other. However, at times participants seemed to spontaneously aggregate in a way that is inconsistent with these expectations. At times the request or expectation to be included in one network (e.g., Facebook) on the grounds that one is included in the other (e.g., the physical one) was perceived as an intrusion.

...there was a social accident: we went outside we did some pictures and put them on Facebook and some of the people inside the close group asked why were we not invited to the dinner, so I started to be concerned about security and the

fact that you need to share everything with everyone [of your Facebook friends]... (Participant L)

...and also my sister joined last year and told me, yes, Facebook...you hadn't told me that you had it... a bit yes (she resented that I hadn't told her I was on it) because she was excited as well... (Participant L)

...I have had a few requests from family friends, I don't like to accept them because that puts more of a restriction on what I can actually say on my Facebook because that exposes me even more to my family. If I did let my family see it makes my Facebook activities more and more public so it restricts what I can write...(if they don't see it) it gives me a wider scope as to what I can write... (Participant G)

The above findings provide evidence supporting the view that context is indeed a multi-faceted, subjective socio-cultural entity. In this study, we have identified five facets. People seem to apply *personal policies* to discern between what they want to share or not with a large audience such as a Facebook network. They seem to exploit *inside knowledge* to establish exclusive communication channels with a limited number of individuals within a larger network. They seem to be acquainted with, observe or rely upon unspoken *etiquette* to protect themselves and to be socially acceptable. They seem to be aware and capable of exploiting proximity to protect themselves and those who are in the network from the intrusion of those who are not. Finally, they seem to be reckoning with the interferences between their Facebook network and the outside world. This indicates a complex articulation of groupings and sub-groupings whose interactions are regulated by individual perceptions, exclusively shared knowledge, communitarian unspoken codes of conduct, and different types of interconnection between the physical and virtual world.

EMERGING CONTEXT: FROM SPACES TO PLACES

Our analysis of context has identified several kinds of boundaries that are central to privacy when people are using mobile technologies. These include personal policy, inside knowledge, etiquette, aggregation and proxemic boundaries. Crossing these boundaries can create tensions which the participants sometimes perceive as intrusions on their privacy. Moreover, they emerge in the moment rather than through being caused by default context indicators such as a set time, location or event. These findings support Dourish's proposal for a more complex notion of context [32]. He recognizes that context is anything that is established by and, therefore, *relevant* to any particular social action and inter-action, for any given actor at any given moment. Conceptually, this recognition has two important consequences:

- the concept that context is defined in terms of relevance implies that context is not objectively defined by settings, actions or actors in themselves, but by the *meaning* that these settings, actions and actors acquire at any give time

from a subjective perspective, where the subject can be an individual, a group or a community;

- the concept that relevance is dynamically established by social action and interaction implies that context is an *emerging* entity; as Dourish points out, this quality also characterizes the social rules that are followed in different contexts, just as it characterizes the meaning of settings, actions and actors.

Dourish's work has influenced research into mobile context, which shows how this is defined by emerging socio-cultural meaning through a process of 'space appropriation' during the use of mobile phones in public spaces [33]. But what do we mean when we talk about 'appropriated spaces'? We propose that space appropriation and context establishment refer to the socio-cultural notion of *place*. The distinction between space and place has a long tradition in sociology and over the years has been applied in fields as diverse as, for example, cinematic theory [34] and Computer Supported Cooperative Work (CSCW) [35, 36]. In particular, here we refer to the notion of place as defined by Gieryn [37].

Gieryn describes place in terms of *investment with meaning and value* as an entity that: "...stabilizes and gives durability to social structural categories, differences and hierarchies; arranges patterns of face-to-face interaction that constitute network formation and collective action; embodies and secures otherwise intangible cultural norms, identities, memories...".

Furthermore: "...place is not space – which is more properly conceived as abstract geometries (distance, direction, size, shape, volume) detached from material form and cultural interpretation. Space is what place becomes when the unique gathering of things, meanings, and values are sucked out..."

The set of features described by Gieryn define the socio-cultural contexts that motivate the establishments of privacy boundaries between people; ultimately, it is this system of characteristics that mobile privacy research has to reckon with when investigating, describing and protecting this elusive entity.

But Gieryn continues: "...neither is place to be found in cyberspace: virtual it is not...websites on the internet are not places in the same way that the room, building, campus, and city that house and locate a certain server is a place..."

This was certainly true before the age of mobile computing, but with mobility the 'borders' of physical and virtual places are becoming progressively blurred as the two worlds (physical and virtual) interfere with each other, and what happens in one affects what happens in the other. Not only do contexts emerge within one or the other, they emerge across the two. Our study highlights the need to systematically investigate such socio-cultural dynamic complexity, if we are to build mobile technology that appropriately responds to it.

CONCLUSION AND FUTURE WORK

Our study of mobile privacy has raised three interrelated concerns. Firstly, to overcome the problem of investigating privacy in context, we combined a variation of experience sampling, making use of a memory phrase chosen by participants. The findings indicate that the memory phrase is a powerful device to elicit detailed information about past experiences even after a number of weeks. Future work could test the effectiveness of the method by reducing and simplifying the experience sampling questions used in association with the memory trigger, to identify the potential trade-off.

Secondly, according to our findings, mobile contexts seem to be multi-faceted entities defined by a complex articulation of groupings and sub-groupings whose interactions are regulated by individual perceptions, exclusively shared knowledge, unspoken codes of conduct, and different types of interconnection between the physical and virtual world. Our study indicates a need to systematically investigate these facets.

Finally, if it is *places*, and not spaces, that determine our need for privacy and the boundaries that are intended to fulfill that need, what are implications for the design of Ubicomp technology? If places are defined by emerging socio-cultural knowledge, functions, relations and rules, what scope is left for user profiling and system automation? Or should design efforts focus on systems that encourage users to be proactive while offering them the support and information they need to manage their privacy [38]? On all three fronts there is much research to be done.

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REFERENCES

1. Barkuus, L. and Dey, A. Location-Based Services for Mobile Telephony: a Study of Users' Privacy Concerns. *Proc. INTERACT 2003*. ACM Press (2003).
2. Consolvo, S., Smith, I. E., Matthews, T., Lamarca, A., Tabert, J., Powledge, P. Location Disclosure to Social Relations: Why, When And What People Want to Share. *Proc. SIGCHI Human Factors in Computing Systems*. ACM press (2005), 81-90.
3. Khalil, A. and Connelly, K. Context-Aware Telephony: Privacy Preferences and Sharing Patterns. *Proc. CSCW 2006*. ACM Press (2006), 469-478.
4. Price, B. A., Adam, K. and Nuseibeh, B. Keeping Ubiquitous Computing to Yourself: A Practical Model for User Control of Privacy. *International Journal of Human-Computer Studies* (2005). 63(1-2), 228-253.
5. Sadeh, N., Hong, J., Cranor, L., Fette, I., Kelley, P., Prabaker, M. and Rao J. Understanding and Capturing People's Privacy Policies in Mobile Social Networking

- Application. *Journal of Personal and Ubiquitous Computing* (2008), 13(6), 401-412.
6. http://www.usatoday.com/tech/science/2008-09-21-big-brother-restaurant_N.htm?csp=34.
 7. Smith, H., Fitzpatrick, G., and Rogers, Y. Eliciting Reactive and Reflective Feedback for a Social Communication Tool: A Multi-Session Approach. *Proc. DIS 2004*. ACM Press (2004), 39-48.
 8. Rogers, Y., et al., Why It's Worth the Hassle: The Value of In-Situ Studies When Designing Ubicomp. *UbiComp 2007: Ubiquitous Computing*. Springer (2007), 336-353.
 9. Antón, A. I., Bertino, E., Li, N., Yu, T. A Roadmap for Comprehensive Online Privacy Policy Management. *Commun. ACM* (2007), 50(7), 109-116.
 10. Consolvo, S. and Walker, M. Using the Experience Sampling Method to Evaluate UbiComp Applications. *Pervasive Computing*, IEEE (2003), 2(2), 24-31.
 11. O'Brien, J. Rodeen, T. Rouncefield, M., Hughes, J. At Home with the Technology: an Ethnographic Study of a Set-Top-Box Trial. *ACM Transactions on Computer-Human Interaction*. (1999), 6(3), 282-308.
 12. Kindberg, T., O'Neil, E., Bevan, C., Kostakos, V., Stanton Fraser, D., Jay, T. Measuring Trust in Wi-Fi Hotspots. *Proc. SIGCHI Human Factors in Computing Systems*. ACM Press (2008), 173-182.
 13. Schilit, B., Adams, N., and Want, R. Context-Aware Computing Applications. *Proc. Mobile Computing Systems and Applications* (1994), 85-90.
 14. Dey, A. K., *Understanding and Using Context*. Personal Ubiquitous Computing (2001), 5(1), 4-7.
 15. Ahern, S., Eckles, D., Good, N., King, S., Naaman, M., Nair, R. Over-Exposed? Privacy Patterns and Considerations in Online and Mobile Photo Sharing. *Proc. SIGCHI Human Factors in Computing Systems*. ACM Press (2007), 357-366.
 16. De Guzman, E.S., Sharmin, M., and Bailey, B.P. Should I Call Now? Understanding What Context Is Considered When Deciding Whether to Initiate Remote Communication Via Mobile Devices. *Proc. Graphics Interface* (2007), 143-150.
 17. Iachello, G., Truong, K. N., Abowd, G. D., Hayes, G. R., Stevens, M. Prototyping and Sampling Experience to Evaluate Ubiquitous Computing Privacy in the Real World. *Proc. SIGCHI Human Factors in Computing Systems*. ACM Press (2006), 1009-1018.
 18. Miner, A.G., Glomb, T.M., and Hulin, C.L. Mood at Work: Experience Sampling Using Palmtop Computers. *Symposium Experience-Sampling Methods in Organisational Research, Society for Industrial and Organisational Psychology*. (2001).
 19. Holtzblatt, K., *Top Field Interviewing Mistakes: Recognizing and Preventing Them*, CHI 2009 (2009).
 20. Proust, M., *A La Recherche du Temps Perdu*. Grasset & N.R.F. (1912-28).
 21. <http://primma.open.ac.uk>
 22. Mancini, C., Rogers, Y., Jedrzejczyk, L., Thomas, K., Price, B. A., Joinson, A. N., Bandara, A. K., Nuseibeh, B. A Multi-Pronged Empirical Approach to Mobile Privacy Investigation. *Workshop Mobile User Experience Research: Challenges, Methods & Tools, CHI 2009* (2009).
 23. <http://en.wikipedia.org/wiki/Facebook>.
 24. Gross, R., Acquisti, A., and Heinz III, J.H. Information Revelation and Privacy in Online Social Networks. *Proc. ACM Workshop Privacy in the Electronic Society*. ACM Press (2005), 71-80.
 25. Acquisti, A. and Gross, R. Imagined Communities: Awareness, Information Sharing, and Privacy on the Facebook. *PET 2006*. Springer (2006), 36-58.
 26. Joinson, A. N. Looking at, Looking Up or Keeping Up with People? Motives and Use of Facebook. *Proc. SIGCHI Human Factors in Computing Systems*. ACM Press (2008), 1027-1036.
 27. Tsai, J. Y., Kelley, P., Drielsma, P., Cranor, L. F., Hong, J., Sadeh, N. Who's Viewed You? The Impact of Feedback in a Mobile Location-Sharing Application. *Proc. SIGCHI Human Factors in Computing Systems*. ACM Press (2009), 2003-2012.
 28. Tolmie, P., Pycocock, J., Diggins, T., MacLean, A., and Karsenty, A. Unremarkable Computing. *Proc. SIGCHI Human Factors in Computing Systems*. ACM Press (2002), 399 - 406.
 29. Esbjörnsson, M. and Weilenmann, A. Mobile Phone Talk in Context. Dey, A., Turner, R., Kokinov, B., Leake, D. *Modeling and Using Context*. Springer (2005), 140-154.
 30. Altman, I. *The Environment and Social Behavior: Privacy, Personal Space, Territory, Crowding*. Brooks/Cole Pub. Co (1975)
 31. Altman, I. Privacy Regulation: Culturally Universal or Culturally Specific? *Journal of Social Issues* (1977), 33(3), 66-84.
 32. Dourish, P. What We Talk About When We Talk About Context? *Personal Ubiquitous Computing* (2004), 8(1), 19-30.
 33. Tamminen, S., Oulasvirta, A., Toiskallio, K., Kankainen, A. Understanding mobile contexts. *Personal Ubiquitous Computing* (2004), 8(2), 135-143.
 34. Gardies, A. *L'Espace au Cinéma*. Méridiens Klincksieck (1993).
 35. Harrison, S. and Dourish, P. Re-Place-Ing Space: the Roles of Place and Space in Collaborative Systems. *Proc. CSCW 1996*. ACM Press (1996), 67-76.
 36. Dourish, P. Re-Space-Ing Place: "Place" and "Space" Ten Years On. *Proc. CSCW 2006*. ACM Press (2006), 299-308.
 37. Gieryn, T. F. A Space for Place in Sociology. *Annual Review of Sociology* (2000), 26(1), 463-396.
 38. Rogers, Y. Moving on from Weiser's Vision of Calm Computing: Engaging UbiComp Experiences. *Proc. UbiComp 2006*. Springer-Verlag (2006), 404-421.