ContextContacts: Re-Designing SmartPhone's Contact Book to Support Mobile Awareness and Collaboration

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ABSTRACT
Acontextuality of the mobile phone often leads to a caller's uncertainty over a callee's current state, which in turn often hampers mobile collaboration. We are interested in re-designing a Smartphone's contact book to provide *cues* of the current situations of others. ContextContacts presents several meaningful, automatically communicated situation cues of trusted others. Its interaction design follows social psychological findings on how people make social attributions based on impoverished cues, on how self-disclosure of cues is progressively and interactionally managed, and on how mobility affects interaction through cues. We argue how our design choices support mobile communication decisions and group coordinations by promoting awareness. As a result, the design is very minimal and integrated, in an "unremarkable" manner, to previously learned usage patterns with the phone. First laboratory and field evaluations indicate important boundary conditions for and promising avenues toward more useful and enjoyable mobile awareness applications.

Categories and Subject Descriptors
H.5. [**Information Interfaces and Presentation**]: User interfaces, Group and organization interfaces

General Terms: Design, Human Factors

Keywords: Context, computer-mediated communication, mobility, self-disclosure, awareness, privacy, situation cues, smartphone

1. INTRODUCTION
During the past decade or so, the mobile phone has profoundly transformed people's patterns and practices regarding mobility and communication [20]. It is used extensively for mobile collaborations like:

- production of near time-space (*e.g.*, meetings and invitations)
- division of labour
- access to remote resources (artefactual or informative)
- consultation
- opinion formation.

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These collaborations, often improvised and opportunistically organized on the move, as contrast to coordinations based on communication over the landline phone, require continuous awareness of the another party's progress and non-progress. One important practical problem for such coordinations stems from the mobile phone's *acontextuality*: from the point of view of a caller, there are no cues whatsoever on the phone on the situation of the intended callee that would hint of progress in the shared tasks or availability for communication. We believe that the lack of shared context is directly manifested in the high tendency to relate location or situation at the beginning of a phone call [4][32] as well as in the high proportion of failed communication attempts.

Motivated by this problem, we are interested in designing a *mobile awareness application* that enhances awareness of others' situations. ContextContacts presents several meaningful, automatically communicated situation cues of trusted others in a format integrated to the standard contact book of Nokia Series 60 Smartphones. We start by reviewing related work, and then advance to present implications to the design of mobile awareness drawn from social psychology. Finally, we present the design, a result of a two-year long user-centered project (see [25]).

1.1 Related Work: Awareness Applications
Mobile awareness applications communicate, automatically or in a user-controlled manner, cues of other people's *current state* or *situation*. In Computer Supported Cooperative Work (CSCW), awareness has referred to "an understanding of the activities of others which provides a context of your own activity" [11]. Conceptually, the cue promoting awareness can be almost anything: social (*e.g.*, "with Liselot"), cognitive ("busy"), positional ("Turku city center"), interactional ("has used the phone for 4 mins"), communicative ("2 unread SMSs"), or a composition of them as in ContextContacts.

Most previous work on awareness has been done in work-oriented, PC-based CSCW. A good system to illustrate this research is NESSIE [24], an awareness environment for cooperative settings in office. The PC application presents events taking place in the office and shows locations of others in places of interest (*e.g.*, shared information or social places). Based on a field study, the authors argue for the importance of *integrating* awareness into existing environments and applications, instead of building special group environments separate from the key activities. They also emphasize the importance of *symmetry* or *reciprocity* between users in event subscriptions.

However, here we want to focus on *mobile* systems, as we believe the case for awareness in mobile collaborative tasks is somewhat different. Nakanishi *et al.* [22] describe a location-aware communication system called iCAMS2 where the phonebook of a

handheld phone shows information about locations of friends. In a field evaluation, its UI for location information was changed five times and feedback collected for each UI. The main finding was that users preferred representations that allowed them to group information: who of the friends is with whom and where, a cue also provided in our system. Friendzone [8] offers a variety of mobile services, one of which is automatic information on friends' proximity (500-1000 m accuracy) and manually entered profiles relating availability to Instant Messaging (IM). In contrast to ContextContacts, location information is not available at the main UI but has to be manually opened, thus hindering easily maintained awareness. Therefore it is not surprising that among 40,000 service subscribers, mainly young adults, the proximity service was not very popular in comparison to IM. ConNexus [28] presents availability information in a mobile device, information that is interpreted from the use or non-use of communication channels. However, ConNexus can also suggest the most suitable communication channel according to a simple set of rules. AwarePhone [5] is a mobile service that aims to support social awareness by disclosing others' availability. Based on a trial conducted in a hospital context, they argue for multiple cues, instead of just location, to support awareness.

We start from these lessons learned. ContextContacts provides a rich selection of automatically communicated situation cues integrated to the standard contact book where the information is available when it is most needed (in a mobile phone): in making phoning decisions. In addition, many novel design ideas and solutions are presented and justified in the rest of this paper.

2. BASING THE DESIGN OF SITUATION CUES ON SOCIAL PSYCHOLOGY

Instead of basing design on trial and error, we aim to reduce uncertainty in design choices by grounding them on findings in social psychology, a "mother discipline" that only recently has been acknowledged to bear on issues relevant to HCI [28]. Our starting point is that the usefulness of a situation cue in inferring another party's current situation depends on two processes: 1) on the individual's *correct inference of a situation cue*, and 2) on the *social interaction afforded by that situation cue*. Consequently, we review findings on social reasoning in the face of uncertain and inadequate information on another person, a situation quite similar to awareness applications. We then review the practices of people interactionally and progressively disclosing cues to each other. Finally, we look at some effects of mobility on social judgments and decision-making. The observations are translated into design requirements in Table 1.

2.1 Perceiving the Other by Means of Limited Behavioral Cues: "Thin Slices"

The typical use situation with situation cues is quite close to the experimental paradigm in social psychology called "*thin slices*". There, participants are shown a video or audio clips of a person, even as short as 200 milliseconds, after which judgments on the person are requested. These brief samples of others' behavior provide information about a wide range of psychological constructs, including mood states, dispositional characteristics, social relations, and job performance. Generally, these judgments draw on the real-world, rich social knowledge that people have acquired, such as knowledge of social ecology, stereotypes, prototypes, and exemplars, and the accuracy of judgments is known to depend heavily on the validity, meaningfulness, veridicality, and relevance of the evidence on which the judgments are based. The accuracy of judgments based on thin slices is also dependent on culture, gender, context, and individual factors. [2] Likewise, in the case of awareness applications, users are able to observe the behavior of others through a limited, impoverished and uncertain channel for a period of time, and it is thus reasonable to assume that the phenomena observed with the thin sliced paradigm might be valid also here.

It is also known that people do not usually engage in effortful conscious processing of complex cues in making social judgments, but utilize heuristics, schemas, and the like to avoid cognitive effort; thus the term *cognitive miser* [13]. Judgments are often made spontaneously, unconsciously, on-line, and from limited behavioral cues. They share many features with automatic cognitive processes; they are characterized by unawareness, efficiency, uncontrollability (*i.e.*, they cannot be stopped), and unintentionality (*e.g.*, they are not begun by an act of conscious will). A potentially crucial difference between awareness applications and the thin slices paradigm is that the first communicate much weaker cues, cues that people may not be accustomed to interpreting automatically. In daily interactions we are not used to making social judgments based on someone's location or phone alarm profile, but on gestures, gazes, looks, movement, talk and so on. Therefore, it is quite possible that users of such applications initially have to relapse on effortful controlled processes in trying to maintain an appropriate level of accuracy. We, however, would like to entertain the possibility that, through the process of learning associations between situation cues and a person's situation, new attribution skills become a natural and automatically executed part of everyday social judgments. More generally speaking, training in this form of *performance feedback* is known to improve the accuracy of inferences based on non-verbal cues [2].

Although research in social psychology has not examined the predictive utility of thin slices to social situations (*e.g.*, meetings) or cognitive states (*e.g.*, interruptability) there is no substantive reason to assume that these would be much different or more complex than motives, social relations, emotions, or personality. However, the question remains whether such weak situation cues will enable making accurate judgments. Another key assumption here is that *extrasituational knowledge* can be utilized. People are known to be better at implicit learning in a social domain, much better for example than in completely analogous non-social domains [6]. Moreover, this can be augmented by general knowledge of events and their scripts. As argued by Goffman [14], almost any interaction scene is more or less culturally scripted, especially its initiation and ending. Furthermore, preknowledge on the other individual can be drawn from. Social intuition is more accurate on friends than strangers [21] and there is a frequently reported in-group advantage in emotion recognition [1]. As a result, even seemingly vague cues, such as time spent in a location or the number of people present, may, with practice, reveal a great deal about another's situation.

Finally, there might be an interesting additional benefit for using awareness applications in a group, namely, in addition to user A knowing that user B is seeing him/her through the awareness application, user C might be able to gather, knowing user B, how B sees A. That is, a kind of *intersubjectivity* because of the interchangeability of perspectives, might emerge through using

Table 1. Social psychological phenomena and related design requirements. Phenomena are described in Section 2 and implementations of the requirements in ContextContacts in Section 3.

Social Interaction Phenomenon	Design Requirement
PERCEIVING THE OTHER	
1. People as cognitive misers. People do not usually engage in effortful conscious processing of cues	1. Integrating judgment support to learned communicative practices in order to minimize cognitive load
2. Veridicality. Veridicality of cues is necessary for accurate social attribution	2. Indicating veridicality and non-veridicality as well as timeliness of cues to user
3. Relevance. Relevance of cues for the intended social attribution task is necessary	3. Selecting informative cues of for typical mobile collaboration situations
4. Meaningfulness. Cues are interpreted by using preexisting knowledge on them and on the situation	4. Using meaningful and familiar context labels instead of raw sensor data
5. Associative learnability. Possibility for associative learning of cues' relationship to real situations is important	5. Providing more information on the cues upon request
MANAGING PRIVACY AND SELF-DISCLOSURE	
6. Self-Awareness. Awareness of how the Self is displayed to others is needed for management of self-disclosure	6. Representing to user how others see him/her at the moment
7. Reciprocality of self-disclosure. People tend to disclose to others as much they disclose to them	7. Providing mechanisms for the quick adjustment of disclosure of cues according to what others share
8. Control. Self-disclosure is often controlled situationally for each group/individual	8. Providing mechanisms for controlling the disclosure of cues to individuals and groups
INTERACTION ON THE MOVE	
9. Temporal organization of social processes. Turns, rhythms, and paces structure mobile interactions	9. Providing timely information on others' turns; supporting rapid responses
10. Limited cognitive resources due to multitasking. Cognitive resources available for HCI are limited due to multitasking	10. Supporting rapid visual search for cues; minimizing cognitive load and the need for task-switching
11. Temporal acuity. Mobile multitasking requires careful temporal orchestration of actions	11. Designing for short interaction chains; duration of interaction must be very brief or interactions postponable

the awareness application, and this is known to be valuable for coordinating group practices [16].

2.2 Controlling what Cues Others Can Perceive: Self-Disclosure and Privacy

However, human relationships are not based on monitoring of others, but evolve through "social penetration" that takes place in a process of progressive and reciprocal deepening and extending through *self-disclosure* [1]. One reason for this is that people model the intimacy of communication to correspond to the felt intimacy with the other person. When this succeeds, people reflect and express *trust and orientation* to the other person, which in turn facilitates further self-disclosure [26]. However, people who disclose too much information, and by that threaten the reciprocity, are generally disliked [9]. *Self-awareness* and the ability to exercise *control* over disclosure are natural prerequisities for satisfactory development of social relationships.

2.3 Managing Social Interaction Decisions while On the Move

Our study on mobility has shown that mobility is often bound to social goals related to collaborative productions of near time-space (meetings, deadlines etc.) [30]. Moreover, we noted the "planful opportunism" in mobility: situated acts are embedded within planned ones. Dropping by, ad hoc meetings, and other forms of sidestepping require planful opportunism and flexibility from other mobility plans, particularly navigation. Importantly, these collaborative productions often take place in a turn-taking manner [27] that requires careful *timing and orchestration* of individual actions and responses.

In addition to social factors, we have examined cognitive factors. Interaction with a mobile device is severely constrained and structured by the limited and fragmented availability of *cognitive resources*, which is by and large due to the cognitive cost of managing multiple mobility tasks simultaneously, many of which are social by nature (*e.g.*, managing personal spaces). Mobile people simply do not have resources for the kind of long and attention-intensive interaction we are familiar with in the domain of PC-based interaction. Indeed, the results of our field experiment convey the impulsive, fragmented, and drastically short-term nature of attention in mobile interaction. Over eight-fold differences in several micro-level measures of attentional resources were recorded in these nine situations, with breakdowns ranging in length from over 16 seconds in laboratory conditions to bursts of just a few seconds in extreme mobile situations [23].

3. DESIGN

In this section, we describe the design of ContextContacts. In justifying our design choices based on the literature review in Section 2, we refer to the summary in Table 1.

3.1 System

ContextContacts is built on top of the ContextPhone platform running on Nokia Series 60 Smartphones. Sensing of context, feature extraction, context description and representation all run within the phone and only the resulting presence data distribution is done over the network. The IETF XMPP/Jabber instant messaging protocol is used for automatic and quick presence subscription and notification (Requirement 9, Table 1). The sensing and presence communication run in separate, fault tolerant processes. For each process, there is a watchdog that

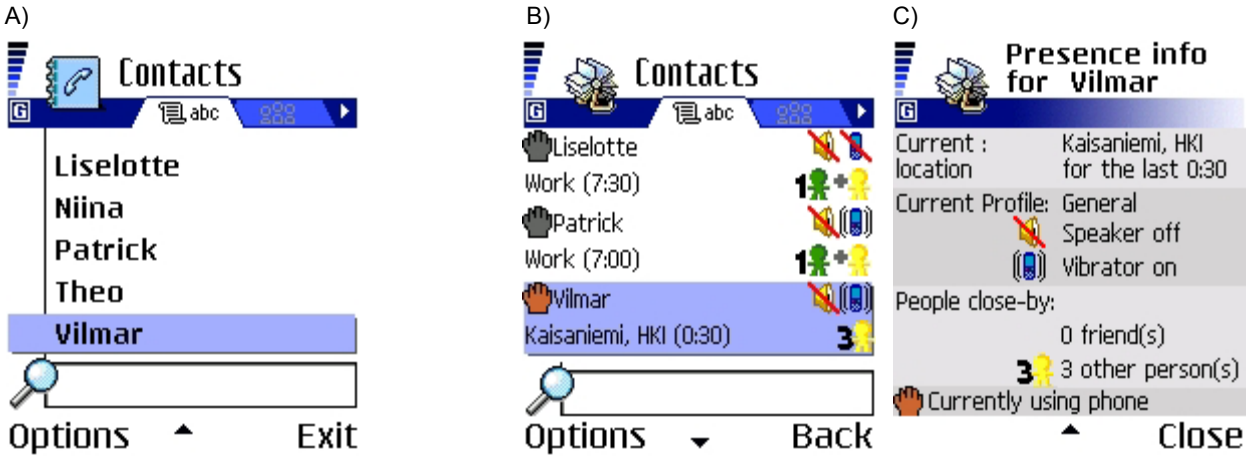

Figure 1. A) The standard, non-augmented contact book of Nokia 6600, B) ContextContacts, C) a detailed information screen for the highlighted contact in 1B. See Table 2 for an explanation of the icons.

restarts it if necessary without user intervention (Req. 11). Errors that occur are logged. For a more detailed description of the system and the underlying platform, see [25].

3.2 Integrating ContextContacts to Series 60 Application Environment

ContextContacts overrides the standard Contacts application of Series 60 Smartphones but looks and behaves very similarly (Req. 1, compare Figures 1A and 1B). Tabs are selectable by left/right pushes and contact rows by up/down pushes with a joystick. A highlighted entry may be called by pressing the call button, and the options menu contains most of the options in the same order as in the standard version. Alternative communication channels, like SMS instead of placing a call, are provided there as well. The only apparent difference is that two lines per contact are used instead of one, which makes scrolling a bit slower.

No user commands are needed to operate the software after installation; the cues are visible and can be utilized immediately. Activating the application and using the cues is as quick as with a native application (Req. 11), and the integration of cues to the contact book ensures that cues can be used in communication decisions without switching between applications (Req. 10). The required effort to learn to use the software is therefore mostly limited to learning the meaning of the cues themselves.

In our pilot field trial, we quickly realized that the Recent Calls list is used almost as frequently as ContextContacts to make calls. Failing to augment the Recent calls list would mean failing to support a significant part of turn-taking activities (Req. 9) in mobile communications. Therefore, the current version of ContextContacts overrides the standard Recent Calls list by an augmented version where the caller's current context information is shown together with the normally shown call information.

3.3 Situation Cues

The design of ContextContacts's *situation cues* is an exercise in design for small displays. ContextContacts provides situation cues on a person in just two rows on the contact list. There is textual information to express location and time spent in that location. Location information is based on GSM cell IDs. However, by themselves, cell IDs are without meaning to a person. ContextContacts therefore automatically fetches, in the background, a place name for the ID from the teleoperators' (Finnish Radiolinja and Sonera) positioning services that provide the city and district name for each ID (Req. 4). However, because ordering positioning SMSs is costly, the names for only IDs where the user spends a significant amount of time [18] are fetched. Therefore, most of the time a meaningful place name is represented, but when the user moves to a new area or moves between familiar areas a question mark is presented. In that case the user is presented with the previous known location. Because the automatically fetched names are not always appropriate, a menu command "Name the place" is provided for the user to override the automatic place label. This user-provided textual description is then published to others every time the user visits in the same GSM cell until it is overridden again.

Most cues are represented as icons to save space and to support visual search and attentional pop-up, which are both important in the quick monitoring of changes in friends' states while mobile (Req. 10). In designing the 16x16 pixel icons, we relied on well-known usability principles: choosing clear, communicative, concrete, and familiar metaphors (Req. 4). Therefore, the icons rely mostly on conventions adopted from desktop operating systems. The cues and their hypothesized relevance for social judgments (Req. 3) are presented in Table 2.

3.4 Interacting with and through Cues

To support the exploration and learning of the meaning of the situation cues (Req. 5), a detailed view of a contact is provided. As illustrated in Figure 1C, all the items shown in the contact book can be expanded to a table, where the cue type is presented on the left and the corresponding value in text on the right.

To support the understanding of veridicality and timeliness of the cues (Req 2.), cue information grays out slowly if the user is disconnected. The graying out takes place in four intervals; in the end, information is so gray that it is barely legible.

To support self-awareness, there is a separate view accessible from the options menu showing (exactly) how others see the user at the moment (Req. 6.).

Table 2. Situation cues, their relevance in making social judgments (Requirement 3, Table 1), and respective UI representations in ContextContacts. See Figure 1B for implementation.

Cue	Significance for social judgments	Representation in ContextContacts
Location	Hints of current place, which hints of activity and task	City (e.g., Helsinki or HKI) and district (Kumpula) / user given description (text)
Time spent in the current location	Hints the temporal extent and phase of the current activity	Hours and minutes spent in the location (text)
User-selected alarm profile	Conveys user-decided interruptability and desired communication channel	Icons for audio and tactile alarm on/off
Phone manipulated recently	Hints proximity and responsiveness to communication attempts	A hand icon turning from gray to red if the phone has or is being used
# of unknown BT phones nearby	Hints of the type of current social activity	If more than 0, a green person icon appears; the number is expressed textually next to the icon
# of contact lists' BT phones nearby	Hints of the presence of friends, and of the type of current social activity	If more than 0, a yellow person icon appears; the number is expressed textually next to the icon

Finally, the reciprocality of self-disclosure is supported so that if the user decides to switch the application off, he/she receives no information on friends' situations either. Therefore, others cannot monitor a user without that user being able to monitor them back (Req. 7). Self-disclosure can be controlled (Req. 8), but only by switching the service fully on or off. We are planning interactions for a better control of what cues are shared with whom.

4. EVALUATION

We have conducted laboratory experiments firstly to compare the meaningfulness and usefulness of situation cues. Secondly, we are running a field trial with a user group of five high school students.

4.1 Useful or Not? Laboratory Experiments on ContextContacts' Situation Cues

One core issue we are interested in evaluating is the meaningfulness and relevance of the cues. Inspired by the thin slices paradigm, we are running a set of experiments to inform us how cues are used to make inferences of remote people and which cues are considered most valuable for situation inferences.

4.1.1 Experiment 1: Role of background knowledge

In the first experiment, we aimed to find out which cues are perceived valuable for situation inferences and whether background knowledge of another person is important in making the inference. Therefore, we presented 10 participants with 5 situation cues adopted from ContextContacts (location, location & duration, profile, manipulation history, number of people present), one at a time, and asked them to list as many probable situations that a stranger vs. a known co-worker could be in, given that information. We then asked them to place an imaginary monetary bet to their guesses, which is a commonly used (intra-subject) measure of *perceived value* in the psychology of decision-making.

The results indicate that location information together with duration spent in that location are considered most valuable (0.7 *scaled value points*, as calculated by dividing the particular bet by the highest bet given by that participant), profile information equally valuable (also 0.7), and the number of people present (0.6) and manipulation history (the red hand) least valuable (0.5). However, in predicting the situation of a complete stranger, location (0.5) and profile (0.6) were only about half as valuable as they were in the case of a known co-worker (0.9 and 0.8 respectively). Another finding worth mentioning here is that fewer situations were named for the known co-worker (3.1 per situation cue on average) than the stranger (3.9), and predictions on a co-worker were considered more probable. Background knowledge of the co-worker could also be used, as predicted, to give more detailed guesses of situations; for example, a guess at the most informative level of location, being at a meeting (room-level) was a guess for a co-worker's situation in 32 % of the situation cues, but in only 14 % for a stranger. Taken together, these results provide promising evidence that preknowledge of a person can be succesfully utilized in making sense of ContextContacts' cues.

4.1.2 Experiment 2: Use of multiple cues

Due to the known cognitive limitations discussed in Section 2, it is unlikely that all of the many cues provided by ContextContacts would be used in making inferences. Quite likely, an inference based on one selected cue functions as an *anchor* for inferring additional cues [13]. Therefore, we were interested in looking at paired combinations of cues. Eight participants were presented with eight cues (the anchors) with real, fixed data (*e.g.*, location="Helsinki Railway station"), again one at a time, and asked to name the most likely situation for a stranger, given that information, and place an imaginary monetary bet on the guess. We chose to use a stranger, because this time we were not interested in, and thus wanted to eliminate the effects of, individual differences in preknowledge. Five of the cues were in the current version of ContextContacts, three of them could be, but are not yet implemented (number of unanswered calls and SMSs, predicted next location with 80 % accuracy [18], and rate of people passing by in 10 m range per minute). Then, for each cue, a list of additional cue types (not fixed with real data) was presented, and the participant was asked to estimate the utility (1-10) of that cue in corroborating or disconfirming the original guess. To address order effects, we counterbalanced the order of presentation of cues by creating four presentation order sets.

To estimate the perceived utility of cue pairs, we calculated *perceived value points* by multiplying the bet given to an anchor cue by the utility given to an additional cue. Of these cue pairs, <"number of unanswered calls and SMSs"(anchor), "number of other people present in 10 m range"> (4.8), <"predicted next location with 80 % probability", "rate of people passing by in 10 m range per minute" (4.6)>, and <"selected profile", "predicted next location with 80 % probability"> (4.5) were the most valuable, whereas <"number of people present in 10 m range"+"when the phone was last used"> (1.2), <"number of people present in 10m range", "number of unaswered calls and

SMSs"> (1.62), and <"duration of stay in the same place", "predicted next location with 80 % probability"> (1.68) were least valuable. These comparisons provide evidence for the idea that the values of pairs are not *symmetric* but the first cue largely determines how the second cue is interpreted, as hypothesized on the basis of literature [13]. An unintuitive and yet uninvestigated consequence is that the UI should highlight the most informative anchors and anchor-cue pairs over less informative ones.

The most valuable (largest bet) anchors were "predicted next location with 80 % probability" (0.75 scaled points), "rate of people passing by in 10m range per minute" (0.70), and "number of unanswered calls and SMSs" (0.68); the least valuable were "when the phone was last used" (0.48), and "number of people present in 10m range" (0.48), and "duration of stay in the current location" (0.51). The most useful (in terms of estimated utility) as the second, additional cues were "predicted next location with 80 % probability" (0.51), "duration of stay in the current location" (0.48), and "location" (0.46). These results show that the situation cues selected for the current version might not be optimal for situation inferences, not as anchors or additional cues—clearly, the three new ones should be implemented and tested.

4.2 On-Going Field Trial

On the one hand, utility estimations in a laboratory condition might not always correspond to inferences made in real life situations, but on the other hand, it is difficult to disentangle the individual contributions of the cues in real field trials. Moreover, the usefulness of the cues for group practices has to be evaluated in the field. Therefore, the two methods are here used in parallel.

For this end, we are currently in the process of evaluating ContextContacts in a field study. The user group is five students attending the same high school and operating a small firm together. They have been using ContextContacts for over a month. In our first focus group, they reported anecdotes of using ContextContacts for coordination and awareness tasks such as:

- *Interruptability inference.* Monitoring interruptability states of others, especially before calling them.
- *Channel selection.* Coordination of initiation of meetings, for example, which requires deciding the best contact channel.
- *Progress monitoring.* Coordination of progress in group tasks, for example deciding *not* to call to announce being late because of seeing that the others are late as well.
- *Location monitoring.* Inferring whether a friend is at school or not, which can be done from location and the presence of Bluetooth enabled phones.

The group has complained mainly about the poor accuracy of positioning.

Our final evaluation will be based on critical analysis of several additional, less subjective measures, such as the success rate of communication attempts, verbal communication of location and other contexts at the beginnings of phone calls, and how frequently the cues were watched and interacted with on the phone (the latter were logged by ContextLogger [25]).

5. DISCUSSION

Brown and Randell [7], in their essay on context sensitive telephony, pondered the possibility of an automated agent blocking calls on the behalf of users. They concluded that a better solution would be to provide the callee's context information to the caller and let him/her make sense of it. In line with this approach, we have presented ContextContacts that follows eleven requirements drawn from empirical findings on social inferences and self-disclosure. As a result, the design is simple, minimal, and integrated to previously learned patterns of using the phone. We have argued that ContextContacts provides an immediate, seamful, timely, usable, and bi-directional instrument for sharing situation cues. Instead of blocking phone calls or relating abstracted interruptability information, it aims for a deeper impact on group coordination and awareness.

Several pieces of evidence that corroborate our approach have been found. The two laboratory experiments indicate that people can take advantage of preknowledge in making situation inferences based on cues, but they do so by anchoring additional information to their first interpretation, a heuristic known to be characteristic of social cognition in general. Large asymmetries were noted in how cues functioned as anchors versus additional pieces of information. Moreover, notable differences in perceived values of different cues where shown and three new, yet unimplemented but feasible, situation cues were found very promising, one of which was based on the idea of context abstraction. These laboratory findings were complemented by results from the field. After a one-month field trial, the user group had experienced and reported several incidents where ContextContacts had supported group coordination, particularly collaborative productions of time-space. The usefulness of its situation cues for social inferences was thus shown not to be merely speculation or a laboratory artefact.

To conclude the paper, we discuss three design topics that, we believe, are of importance for future work in mobile awareness.

5.1 Unremarkable Computing?

Looking back at the design philosophy of ContextContacts, it is impossible to escape noting its relationship to the *unremarkable computing* recently proposed by Tolmie *et al*. [31]. They analyzed everyday routines in social interactions, even such mundane ones as knocking on a door before entering a room. They observed that in order to be invisible from the perspective of fluency of social practices, new technologies should not override or replace these practices, or change their semantics, but to support them: augment and provide resources and alternatives for streamlining and performing them. Similarly, ContextContacts does not aim to override existing practices, but to provide contextual resources and augmentations for them.

This raises two issues. First, although we have argued that the Contact Book is a natural place in which to elegantly *integrate* context information in mobile phones, we do not want to conclude that it would be the only place—think for example group calendars, SMS and email inboxes, or other applications utilized in group practices. Second, it bears a stance toward how we, as designers, see *context*. Designers of agents that block phone calls can easily be lured to assume that interruptability is a state of the world (or of the person) that can be simply inferred from sensor data, whereas a social scientist would say that interruptability is a result of social construction among the interrupter and the interurptee and interruptability therefore is not visible *per se* but constructed in the minds, actions, and interactions among the involved parties. This view that comes close to the *interactional view of context* [12] has inspired us to provide as many

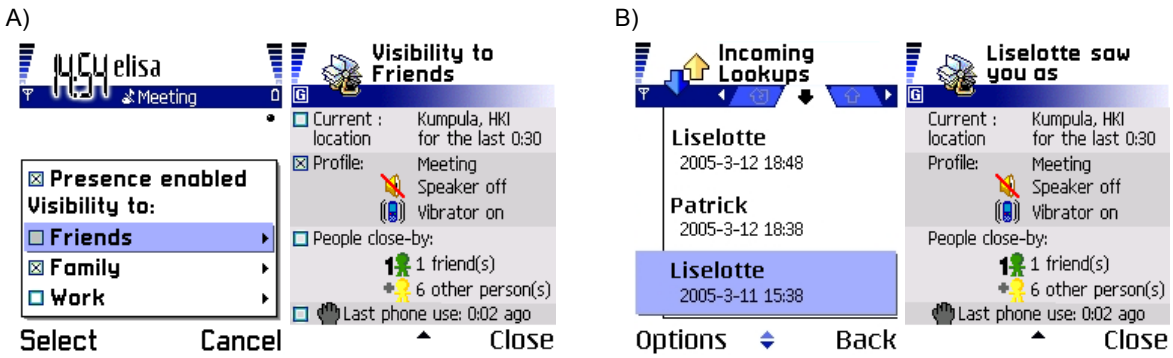

Figure 2. Managing self-disclosure in the new version of ContextContacts: A) visibility control and B) lookup logs.

(reasonable and useful) ways as possible to represent contexts and situations, for the users themselves, and do so in a way that respects and affords maintaining practices of accountability.

5.2 How to Make Cue Sharing Accountable?

One main challenge for future work is related to the *social management of self-disclosure* through the interface. Currently, one important part of accountability practices is not supported: users have no way of knowing how often others have looked at them; they may feel unnecessarily tracked or they might actually be monitored often by somebody as there are no limiting factors for monitoring. Therefore, we are implementing a *lookup log* to ContextContacts for our next field-study. It will allow participants to see how and who monitors them, bringing possible negative consequences into the realm of social control. To reduce unnecessary feelings of being monitored and bring actually occurring disclosure under social control—making recipients accountable for receiving and using the information, each 'lookup' of context information is logged and made visible to the discloser. The discloser now has accurate information on what the actual disclosure through the system is (Figure 2B).

This feature is augmented with an interface for controlling what information is shared to whom (Figure 2A), as well as an option to receive auditory or subtle tactile notifications over changes in others' visibility. We now provide a multi-level control of what is disclosed to whom, based on user-selected groups of receivers: the service can easily be switched on/off, groups can quickly be included/excluded and the user can, if necessary, take detailed control over exactly what is disclosed. We acknowledge the fact that users may have nearly as many selves as they have significant interpersonal relationships. These selves are called relational selves, as they are evoked when the significant-other representation is activated [3]. Therefore, we believe that in addition to be able to control visibility to all users, users would some times appreciate the ability to control disclosure in a one-to-one manner. Our forthcoming field trial explores this issue.

5.3 What User Groups are Most Likely to Benefit from and Adopt ContextContacts?

It is worthwhile to extend our speculations on the potential user groups of mobile awareness applications and ContextContacts in particular. Lickel *et al*. [19] distinguish between four types of social groups that individuals perceive: intimacy groups (*e.g.*, family, groups of close friends, street gangs, fraternities and sororities), task-oriented groups (*e.g.*, labor unions, co-workers, juries, people taking an exam together), social category groups (*e.g.*, Women, Blacks, Jews), and loose associations (*e.g.*, people in the neighborhood, those who drive red cars). Intimacy and task-oriented groups are those most likely to accept and benefit from awareness applications such as ContextContacts, as they are typically 1) long-term relationship involving in-group similarities, implying pre-existing knowledge of other members' situational patterns, 2) sharing goals and outcomes, implying genuine interest in others' situations, and 3) having high or moderate levels of interaction, implying ability to learn new situational patterns in a moderate time. These qualities might be necessary for building the kind of skills and trust needed to share one's context in awareness applications. It should, however, be noted that *non*-hierarchical groups do not abolish the need to judge privacy management critically. The *chilling effect* [10] of such monitoring must be evaluated, studied and countered.

5.4 Optimizing Group Coordinations or Providing New Opportunities for Action?

Finally, we want to note that there is an alternative way of looking at the *transformative capacity* of awareness applications. Specifically, we believe that situation cues afford *novel social opportunities* instead of just improving or optimizing existing practices (a dominant focus in mainstream CSCW). Some work has already been done with this perspective in mind. For example, Victoria Institute's mobile "inter-personal awareness device" [15] that indicates the identities of people close by (< 100 m) was used for unpredicted (for the researchers) and uninstructed (for the users) purposes depending on the user group and context. In a work context it was used for finding people present, in a rock festival context it opened up new "excuses" for approaching others, and in a conference context it was used for coordinating a pre-arranged meeting and noting when others come to an unspecified event. Likewise, Hubbub [17], a sound-enhanced mobile IM application, provides automatic online/offline information, a field for manual description of state, and an indication if the user is typing in the IM. Their field trial indicated that awareness provided resources for opportunistic interaction, which in turn helped in building groups. However, some observations from our trial suggest that not all opportunities might be positive. For example, one user said that during dull lectures he could use ContextContacts to find a friend whose audio alarm is on and make a call to embarrass him/her in the face of the class.

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