### **MEDIATED AWARENESS** FOR INTRA-FAMILY COMMUNICATION

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### **MEDIATED AWARENESS** FOR INTRA-FAMILY COMMUNICATION

PROEFSCHRIFT

ter verkrijging van de graad van doctor aan de Technische Universiteit Eindhoven, op gezag van de rector magnificus, prof.dr.ir. C.J. van Duijn, voor een commissie aangewezen door het College voor Promoties in het openbaar te verdedigen op woensdag 11 november 2009 om 16.00 uur

door

Vassilis Javed Khan

geboren te Thessaloniki, Griekenland

Dit proefschrift is goedgekeurd door de promotor:

prof.dr.ir. J.H. Eggen

Copromotor: dr. P. Markopoulos Στη μητέρα μου Βενετία, τον πατέρα μου Ναβάμπ και τον αδερφό μου Αλέξανδρο οι οποίοι διαμόρφωσαν τον δρόμο που διαβαίνω σήμερα.

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## **CHAPTER 1: INTRODUCTION**

"Seek knowledge from the cradle to the grave", Prophet Muhammad

#### **1.1 SCOPE AND MOTIVATION**

"You twitted that you were uploading photos of the baby on your Facebook profile and I have sent an instant message to father to let him know about it. Do you have time to Skype tonight to tell me all about the baby?"

This is an excerpt of an email sent by my brother on the occasion of our new born baby. This is the type of conversation that nowadays becomes common language not just among technology enthusiasts but increasingly so by many more people. The proliferation of new communication applications over the Internet and mobile devices that support easy access to such applications has profoundly changed the way a lot of people communicate. As is often the case with technological innovations, media such as Twitter, Facebook, Skype and other similar internet based communication applications initially drew the interest of technology aficionados and office workers. By now, these media are being used increasingly by other groups. One such group is families. Even though these media have been used for a variety of purposes one core motive for their use is the information exchange of activities, experiences and whereabouts of people. This kind of information could be characterized as awareness information.

*Awareness* is understood in the context of this thesis as: An understanding of the status, activities and whereabouts of connected others, that provides a context for your own activities and experiences (adapted from Dourish and Bellotti (1992)). Information that would help people in creating and maintaining that understanding would extend this definition as *awareness information*.

Although such media bring added value to the communication of people, a shortcoming they have is that their users need to explicitly input awareness information. A question that arises is how people would react to applications that would automatically capture and communicate awareness information on behalf of them. Moreover, in the case of families, do such applications or systems have a role to play in supporting their family communication? Especially when family members are already living together and already have a high degree of awareness of each other's rhythms of daily life, their whereabouts and needs. Do such systems have a role to play when family members already extensively use mobile phones, regular phones and email? Even if there are benefits for families to use new communication media, do they bring any costs? Would there even be a chance that such systems, instead of supporting families in their communication, would actually spoil their communication?

The research presented in this thesis addresses this type of questions. In 2004, when this research endeavor began, the aforementioned communication applications did not exist or were still in their infancy and concepts such as sharing of information about one's location and activities seemed far fetched. By now some of these concepts have become commercially available and the research questions we described even more relevant.

More specifically, the research presented in this thesis has two objectives. The first objective is to investigate the current communication practices of family members to stay in touch with each other. Based on this investigation it elicits requirements for new pervasive communication systems which aim to support intra-family communication. The second objective is to develop new systems based on the elicited requirements and evaluate them.

In this thesis we focus on families who consist of working parents with dependent children living under the same roof. We shall call such families "busy families". The primary interest in addressing this user group is that these families have hectic professional lives which put under pressure their personal lives and their communication with their beloved ones. In summarizing the motivation for the research work presented in the chapters to come, one of the main questions addressed is whether there are unmet awareness needs for this particular group and if so, how can new communication systems address these needs.

The fact that this group of people already has daily and direct contact, apart from a variety of mediated communication possibilities, raised skepticism about the role of new communication systems, in the initial phases of the project. What role can new systems have in the already crowded mediascape of the lives of family members? This critical standpoint was instrumental in the approach and the early development of this work.

#### **1.2 PERVASIVE COMPUTING AND AWARENESS SYSTEMS**

But before presenting the approach we took in this work, the new emerging communication systems need to be defined in more detail. Many of the new communication systems can be categorized under the term "pervasive computing". In 1991 Mark Weiser, a researcher at Xerox PARC, published his vision of ubiquitous computing (ubicomp<sup>1</sup>) (Weiser, 1991). In this vision he stated that future computers would become embedded in all everyday objects while they are networked with each other. He also sketched the changing nature of communication applications by stating that in the future "receptionists actually know where people are", implying people's location awareness and automatic sharing of location information. Weiser's vision reverberated in research labs worldwide, giving rise to related conceptions of pervasive computing such as "ubiquitous computing" (ubicomp) and "ambient intelligence".

Although pervasive computing has spread into many subfields, this thesis will focus on the changes and developments it brought onto communication applications. Abowd and Mynatt (2000) distinguished the following three themes of ubicomp: *natural interfaces, context-aware applications* and *automated capture and access*. The research reported in this thesis can be categorized under the third theme. It pertains to the conception, design and development of *"tools to support automated capture of and access to live experiences"* (Abowd and Mynatt 2000). The motivation Abowd and

<sup>&</sup>lt;sup>1</sup> The terms ubicomp, pervasive computing and ambient intelligence are interchangeably used

Mynatt provide is to "remove the burden of doing something humans are not good at (i.e. recording) so that they can focus attention on activities they are good at" (Abowd and Mynatt 2000). In the case of this thesis we attempt to design and develop systems that will remove the burden of capturing and communicating awareness information between family members so that family members can focus their attention in exchanging experiences and connecting with each other.

Such systems are commonly referred to as *Awareness Systems*. They are typically defined as a class of computer mediated communication (CMC) systems that support individuals to maintain, with low effort, awareness of each other's activities and whereabouts (Markopoulos et al., 2004). This is in contrast to systems whose primary purpose is to support direct, rich and goal-oriented information exchange, such as email, shared document repositories, video-conferencing applications, etc. It is noteworthy to state that our focus and interest is in Awareness Systems and not Context-awareness. Context-awareness is a broader field in the sense that it is not necessarily focused in communicating context information between individuals per se. Moreover, in the field of Awareness Systems we find researchers including in their system design, information which is not necessarily context information (such as exchanging short messages).

Initially, awareness systems were developed and researched with regards to their work-related use. Rittenbruch and McEwan (2009) in their 'brief history of awareness' mention as pioneering work the study of Kraut in 1998 in aspects of collaboration to create scientific publications, the study of Harper in 1989 in air traffic control and finally the study of Heath and Luff in 1991 in the London Underground's control room. One of the first systems that could truly be classified as an awareness system, following the definition above, was called "Media Space" and was created at Xerox PARC in 1986 (Bly et al., 1993). Analog video and audio feeds were transmitted between four offices in Palo Alto and Portland of Xerox which allowed office workers to communicate informally and be aware of opportunities to interact with others.

It was only in the mid '90s that the first research attempts concerning awareness systems shifted from the work domain to leisure and social use. Pioneering work were the design concepts developed by Strong and Gaver (1996) but it was not until after 2000 that awareness in the home was addressed explicitly (Hindus et al., 2001, Mynatt et al., 2001). This is the field of research which is most closely related to this thesis. Within the home domain there are naturally many different application areas but the focus of this work is in eliciting requirements, developing and evaluating awareness systems to support intra-family communication.

In this category of systems there is a plethora of examples available within the research community. In terms of the presentation of awareness information, systems can be classified in four categories: A) systems which use a static display such as a photo-frame, public display or a desktop application, B) systems which use mobile phones or a personal handheld device C) systems which are decorative and D) systems which are wearable. In the following paragraphs we introduce some pioneering awareness systems and the ways they have shaped the development of this field. A thorough review of related systems and research efforts will be covered in each individual chapter.

One of the initial goals of awareness systems was to present the propagated information to the background of the users' attention. The motive in this case was on the one hand to present the information in a calm manner (Weiser and Brown, 1996) and on the other hand to allow the user to focus on other tasks while he was being made aware of other people's context. Accordingly one of the most influential works was the Digital Family Portrait which made use of a photo-frame as a platform to display awareness information (Mynatt et al., 2001). Such systems would enhance the main purpose of the frame, which was to sequentially present photos, with awareness information. The Digital Family Portrait displayed an elderly person's activity information gathered by sensors which were placed at the senior's home on a photo-frame system at her children's home. This project proved to be influential for several other projects such as CareNet (Consolvo et al., 2004), the Whereabouts clock (Sellen et al., 2006), Photomirror (Markopoulos et al., 2006) and the Digital Diarist (Metaxas and Markopoulos, 2007). CareNet (Consolvo et al., 2004) also used data retrieved by sensors at an elderly person's house to display the information to extended family members. The Whereabouts clock (Sellen et al., 2006) was developed as an appliance hanging on a kitchen wall, concealing a computer display through which awareness information of the whereabouts of family members is presented. Photomirror (Markopoulos et al., 2006) was developed as a large mirror that hangs on the wall of the hallway. It had attached a camera, motion sensors as well as a screen. Photos were automatically taken when the motion sensor was triggered and then displayed on the attached screen. Short videos could also be explicitly captured by the user. Finally, the Digital Diarist (Metaxas and Markopoulos, 2007) took further the concept of combining sensors at the home of an elderly to inform members of his extended family by creating a narrative presentation of the sensor data. A project which also should be mentioned is the Scan Board which enables two households to share a writing surface. This concept was one of the outcomes of the Casablanca project (Hindus et al., 2001). Scan Board also aimed to connect individuals on different households however by explicitly sharing messages rather than inference of context information through sensors and communicating that information automatically to a photo frame device.

Offspring of these projects used the desktop PC and the mobile phone either in combination with photo frames or as stand alone devices on capturing and communicating awareness information. The ASTRA project (Markopoulos et al., 2004) was pioneering in shifting awareness systems to combine mobile phones with photo-frames as well as gathering quantitative evidence of the affective benefits of such systems. Through ASTRA, mobile individuals were enabled to share photos with family members at home who could view the photos on a photo frame device. Other awareness systems on the mobile phone include ConNexus and Awarenex (Tang et al., 2001) and ContextContacts (Oulasvirta et al., 2005). ConNexus and Awarenex were one of the early attempts to provide awareness (activity and location) information to desktop and mobile phone users. ContextContacts enhanced the standard Nokia mobile phone contact book with awareness information such as the location of a contact, the remote contact's mobile phone settings.

Another offspring of the initial photo frame projects were applications which resided on the desktop PC. Examples of such applications are Sideshow (Cadiz et al. 2002) and the Community Bar (McEwan and Greenberg, 2005). Sideshow is a peripheral awareness interface that appears on the right side of a Windows desktop. The sidebar is filled with a variety of items each of which provides a relatively high-level summary of information in a small screen space. Sideshow has been integrated in the Microsoft operating system, Vista. The Community Bar combined presence information with video conferencing and instant messaging to provide an office awareness system. In other systems the desktop was "camouflaged" to fit the expectations of users creating a more appropriate design. Such a case is the Interactive Messaging and Reminder Display developed and designed for elderly and caregivers (van Veldhoven et al., 2008). In this project a secretaire, selected by the designers for its traditional appearance, was used as a shell to hide a laptop, extension cables, a hub and also accommodate a webcam and a printer. Through this system family and friends were able to add messages which were displayed in the system placed at the elderly's home.

Other awareness systems have gone beyond computer devices and have explored the decorative side of awareness systems. A pioneering concept was The Feather (Strong and Gaver, 1996). The Feather used two devices, one small object which was supposed to be carried by a traveler through which the traveler could indicate that his or her attention was focused on the person staying back home. The other device was at home and when it received the signal of the traveler a feather wafted into the air. Similar critical design works include the "Dangling String" and the "Intentional Presence Lamp". The Dangling String created by artist Natalie Jeremijenko, was a long plastic string which swung according to the data traffic of an Ethernet network (Weiser and Brown, 1996). The Intentional Presence Lamp was a lamp controlled remotely by a connected household through which distant individuals could signal to each other their presence at home (Hindus et al., 2001). A related project which brought the decorative aspect of awareness information into a public display was The Data Fountain (Eggen and van Mensvoort, 2009). The Data Fountain was first displayed in public in 2003 and represented an artistic awareness system which displayed the exchange rates of three currencies (the Yen, Euro and Dollar -  $\xi \xi$ ) through a fountain.

Compared to the plethora of screen based systems, there are relatively few published examples of wearable awareness devices. A pioneering work for its time was the WatchMe system (Marmasse et al., 2004). WatchMe adopted the form factor of a wristwatch. This device could support communication through awareness cues, text and voice messaging. Another wearable related concept was the Hug Over a Distance (Vetere et al., 2005). Hug Over a Distance recognized the affective value of mere communication acts and through this system one could give a virtual hug to a person at a different location. The hug was created by an inflatable jacket which one could use to communicate one's affection to a remote person wearing it.

Although the motivation for creating such systems varies, most systems aim to connect people by informing them about the status, activities, whereabouts and in general the context of other people.

In the context of this thesis we developed two systems: *SchoolAware* and *FamilyAware* which we will present in detail in the following chapters. SchoolAware can be categorized as a static display system, whereas FamilyAware is a mobile phone system.

During the period 2004-2008, awareness concepts have shifted from purely research driven to market oriented. Different communication technologies have been applied to enhance social contact and family communication. Nabaztag (nabaztag.com) is a rabbit-like robot which connects to the WiFi network and by connecting to a dedicated site it reads out messages, emails and SMS messages sent by friends and family. Moreover, Nabaztag reads out weather forecasts, the stock market and it can be set to retrieve and read out other information sources. Mir:ror, another product of Violet, the company which conceived Nabaztag, reads RFID tags. Each RFID tag can be programmed to trigger several actions. The Mir:ror uses USB to connect to a computer. For example a tag can be attached to a child's keychain, when the child comes home and places the keys on the Mir:ror, an email is sent to the parents. Another scenario presented by the company is attaching a message to a stamp. For example, a user can attach remotely, through the website of the product, a message to a shopping bag carried by his spouse such as: *"Please remember to buy some cheese"*. When his spouse "scans" the shopping bag to the Mir:ror then the message is heard through the computer.

Connectedday is a commercial example of an awareness service rather than a product. Connectedday (connectedday.com) is a community site aimed at professional daycare providers and their clients, parents and children. Connectedday provides a camera phone to daycare center employees and an easy way for them to upload photos on a website. Through that website parents can stay up-to-date with their children's activities. Other examples of commercial awareness services include systems such as Google Latitude, Yahoo Fire Eagle, Loc8tion.com, Loopt.com as well as various Facebook location-aware related applications such as FindMe which are nowadays supporting location sharing among family, friends and coworkers.

#### **1.3 METHODS FOR RESEARCHING USER EXPERIENCE IN CONTEXT**

Ambient Intelligence and related visions such as pervasive computing, ubiquitous computing, etc., signal a move towards embedding information and computational technology in our social and physical interactions making it an inseparable part of daily life. For researchers, designers or technologists attempting to design, analyze, or create user experiences this transition poses serious methodological challenges.

Existing research and evaluation methods have been shaped to address the evaluation of taskoriented interaction, usually contained within a short time span. Extending characterizations and evaluation methods to address user experiences as they occur in context, reflecting social interactions between several people and various environmental and technical contingencies, requires scaling up the sampling of data in frequency, duration and in the richness of the measurements and recorded information. The objective of the evaluation has also changed significantly. Transcending usability, evaluations of ambient applications need to consider higher level aspects of user experiences and user needs relating to persuasion, fun, engagement, trust, etc. Evaluation practices must be able to account for, capture and investigate the variability of contexts described above, allowing experimenters to manipulate and control those environments or, when working in the field, to capture sufficient contextual information.

Contextualized methods of data collection should allow reports of attitudes, opinions, or appraisals of subjective experiences to be captured close to the moment that a particular experience occurs, i.e., in the context that events and activities unfold. Also, such sampling of user attitudes can occur repeatedly over time, allowing the study of behaviors and experiences over medium or long periods of time, to uncover temporal patterns or to examine patterns of use over time.

One well established method that addresses these requirements to a large extent is the diary method whereby informants are asked to keep a journal or a log, where they record events, activities and experiences regularly over a specified period of time. In traditional diary studies informants record data, usually in writing, but often combining or even replacing written records with other recording media, see for example Carter and Mankoff (2005).

In diary studies, the initiative for capturing information is left completely up to the informants who have to remember and take the initiative to report in their diaries. This may be detrimental to the quality of the data collected for several reasons. Informants may forget to enter information in diaries, or entries may be made at moments that they have the time and appetite to do so, rather than the ones of interest to the researcher. This can lead to loss of data and systematic response biases.

For these reasons, the Experience Sampling Method (ESM) is gaining ground in human-computer interaction studies for understanding human behavior to design better products and services and for studying use in the field. The ESM is a quasi-naturalistic method that involves signaling questions at informants repeatedly throughout the sampling period. For example, informants may be given a pager or even another notification device through which they may be reminded to fill in a set of questions in a diary. To allow for flexible sampling and surveying approaches, researchers have turned to the use of handheld computing devices (Smartphones or PDA's), that participants are required to carry through the study period and through which the question-asking protocol is applied.

In the field of human-computer interaction Consolvo and Walker (2003) applied the ESM in evaluating an Intel Research system called Personal Server. Hudson et al. (2002) used the ESM to explore attitudes about availability of managers at IBM Research. Froehlich et al. (2006) used ESM to investigate the relationship between explicit place ratings and implicit aspects of travel, such as visit frequency. A noteworthy clarification is that the research presented in this thesis extends beyond an evaluation of a user's experience of a product or service. It extends by attempting to reconstruct the user experience in the field for eliciting requirements to design a service. Thus the state of the art definition of user experience: "a momentary, primarily evaluative feeling (good-bad) while interacting with a product or service" (Hassenzahl, 2008) would not quiet fit the context of the research in this thesis since this research goes beyond interacting with a product or service. Therefore a more appropriate definition of user experience would be: "Experience itself is an ongoing reflection on events, we currently go through" (Hassenzahl, 2008). The emphasis on the reported studies is on choosing which method to use in order to capture the needs of a user (which would reflect to the requirements for a product or service) **and** at the same time capture the user's context. In that way one could abstract and examine the user needs (and therefore the design requirements) under certain context.

#### **1.4 APPROACH AND RESEARCH QUESTIONS**

This research project started off with the 'Ambient Awareness' concept in mind. Ambient Awareness aimed to integrate aspects of Ambient Intelligence into Awareness Systems, in order to support informal and lightweight social communication. The focus was on connecting households with mobile individuals in order to help people to stay in touch with close friends and family. More specifically Ambient Awareness was envisioned to comprise of the following two elements:

**Automatic Capture of Awareness Information**. A sensing environment can semi-automatically construct a model and an audio-visual record of residents' activities.

**Pervasive Awareness**. Mobile devices entering an aware environment may "negotiate" awareness information exchange with this environment. The environment may compile a context model from information taken from multiple devices; vice versa, each device may obtain awareness information from the environment.

The initial goal for this research was to explore the concept of Ambient Awareness and its acceptance by end-users. In order to achieve this aim a series of investigations were conducted to answer the following research questions:

- Do people actually need and want awareness of each other provided by technological systems?
- Would such awareness systems improve people's communication and lives or would they worsen the existing situation?
- What are the issues that prevent the acceptance of such systems and how could they be addressed by appropriate design?

In other words, the research endeavor began by wanting first to find out what information is of true value for intra-family awareness and based on those findings shape the concept of Ambient Awareness to fit the needs of people rather than the other way round. Moreover, while trying to address these questions another question, a methodological one, was raised on the way.

• How can user experience data be reliably collected from the field?

The approach followed in this thesis to answer the aforementioned research questions, combines theoretical, empirical and design activities based on the triangulation framework of Human Computer Interaction (HCI) (Mackay and Fayard, 1997). The triangulation framework proposes a combination of science and design to support the study of interactions between people and created artifacts. Research proceeds through an interchange of theory development, design and empirical studies. More specifically, this thesis follows the framework as illustrated in Figure 1.



Figure 1: Components of the triangulation framework followed in this thesis

The first study approached the problem at hand by interviewing participants of the chosen target group of busy families (Chapter 2). Interviewing is an open, qualitative method which allowed current communication practices, hindrances and the reasons for those to surface. The results of this study, analyzed with the help of a custom-built tool named Interlysis (see Appendix I), helped to better understand the communication needs that current media fail to address and the context in which ambient awareness could meet them. More specifically, one of the main results of this study showed the hesitation of participants to allow pervasive computing to support communication with their partner. This reservation triggered further investigation of this aspect via a web-survey (Chapter 2). The second result highlighted the interest of parents to stay in touch with their children. This was the driver for the design and evaluation of the SchoolAware system presented also in Chapter 2. SchoolAware represents an awareness system which communicates the presence and schedule of children during school hours to their parents to obtain through an awareness system and a check whether or not they would be truly interested in the proposed awareness solution.

The web survey study revealed how important context of use is when trying to infer the unmet communication needs of people and a natural progression was to bring context in by using the Experience Sampling Method in Chapter 3. Lack of tools to support the execution of such studies led to the design and development of Reconexp, a distributed system running partly on mobile devices and partly on a website. The results of the experience sampling study along with the other studies led to the design and development of FamilyAware a second awareness system (Chapter 5), designed to support the unmet communication needs of busy parents.

Another important aspect of the research approach we followed was that for all studies the user, i.e., a member (or members) of the busy family, was always in the center. In the user-centered approach the person who is intended to use the final product is studied closely and his context and needs are in the focus of the research (ISO 13407, 1999). This approach is most suitable in the case of intra-family communication. On the one hand the relationship between family members is not only the most salient for people and the society but it is also a subtle one. Communication is probably the most important aspect of creating and sustaining a good relationship. To support intra-family communication one needs to closely investigate the relationship between family members to gain a deeper understanding of what can be improved in their existing communication but also understand the aspects that might harm the communication and subsequently the relationship of family members.

To design and develop new communication technologies for such a group one needs to focus on and research their practices and lifestyle, understand these and inform design. The group of people researched in this thesis is families in which both parents are working, they have at least one dependent child and live in the same household. We studied the way busy families used mediated communication. Focal points for this research are the media they use, in what way they use them, where they use them, when they use them, with what frequency and most importantly for what purposes. The families that were encountered during this research had established routines in their lives, however within those broad routines an enormous variation was observed. Some of the mundane aspects of the lives of family members include getting prepared for work and leaving the children at school, traveling to work spending most of the day at work and traveling back home at the end of a working day, picking up children from school and having dinner with all family members. In addition to these aspects of everyday life, family visits, events at school, children's extracurricular activities and short business trips represented examples of activities which broke the routine. In terms of communication media usage, this group of people mainly used synchronous communication and especially the mobile phone and much less asynchronous communication such as email. Exchange of short messages by using the mobile phone (SMS) was extremely rare for this group. The preference of synchronous media over asynchronous made the research of awareness systems even more interesting since current asynchronous media require explicit input of information. The interesting point of research would be to investigate whether asynchronous media with implicit input of information would be adopted by this group. An example of implicit input would be information that is collected by computer or phone use, even sensor-captured data.

Since this research is dealing with awareness of context it is evident that the broader context of the country in which our studies were conducted, including its people, has a great influence on the outcome of the research. Participants in this research represented a broad range of people. Their jobs varied from truck driver to university lecturer and from secretary to business manager. Their educational level and socio-economic status varied as well. On the other hand, it is noteworthy to mention that the living standard of the Netherlands, the country in which this research took place, is relatively uniform and the social perspective of people is quite egalitarian. Nevertheless, the families

and participants who participated in this investigation share in broad lines the same core ethical values such as the attention of parents towards the upbringing and well being of their children, the dynamics of relations between children and parents, the emotional bonding of couples and the driving force of people in forming and building families. Therefore it is understandable that a lot of the results brought forward in this research will apply for many more people than the people who kindly participated as interviewees, informants in field studies or test participants. That is not to say that the research results presented in this thesis would unquestionably apply to other cultures and societies; it is rather that the research reported in this thesis presents some important findings which might apply to other people and would be a point of reference for further investigation and comparison. Thus, further research would be necessary to identify the applicable and relevant parts of the research presented in this thesis to other countries and cultures.

Finally, it should be stressed that the emphasis in this thesis is the design challenges of awareness systems. This thesis takes an empirical approach in identifying communication related needs, which would inform the design of awareness systems. However, there is considerable literature in social psychology that emphasizes the importance of essential human needs for people's survival and well being, such as social inclusion, connectedness, belongingness and intimacy. The review by Baumeister and Leary (1995) and a more recent by Bel et al. (2009) could serve as a starting point in this regard.

#### **1.5 CONTENTS OF THE THESIS**

This first chapter provides an introduction to the thesis, motivating the research questions and the research approach followed. The content of the remaining chapters is outlined below.

Chapter 2 reports on three studies that aimed to answer the following research questions: (a) Do families want to be aware of each other through the day? Or, would they perhaps rather not know more about each other's activities and whereabouts than they already do? (b) If they do wish awareness support, what should they be aware of? The research involved in-depth interviews with 20 participants, a field trial in which an awareness system connecting five "busy" parents with their children was studied and a survey of 69 participants conducted over the web. Combining the results of the three studies leads to the following conclusions: (a) Some busy parents want to automatically exchange awareness information during the day while others do not. (b) Availability of one's partner for coordinating family activities, daily activities in new family situations, activity, and location information of dependent children are salient awareness information needs for this group. (c) Awareness information, needs to vary with contexts, suggesting the need for flexible mechanisms to manage the sharing of such information.

In Chapter 3 a variation of the Experience Sampling Method was applied. The data collected provide evidence in claiming that the innovation brought to the method might be a useful one. Therefore Chapter 3 presents the evidence for the claim. The method is called Experience Sampling and Reconstruction Method (ESRM). ESRM combines aspects of the Experience Sampling Method and the

Day Reconstruction Method aiming to reduce data loss, improve data quality and reduce the burden of regularly responding to questions, put upon participants. Reconexp (named after: reconstructing experience) is a tool developed based on the ideas of ESRM and its practical execution. Reconexp is a distributed application, which partly runs on a mobile device and partly on a website, enabling researchers to survey user attitudes, experiences and requirements in field studies. The first experiences of using this method and the tool developed, in the context of a study of communication needs of working parents with young children, are presented in Chapter 3.

In Chapter 4 the results concerning the communication needs of our participants in the Reconexp study are presented. Chapter 4 presents research which tries to investigate awareness needs of busy parents under context. In this way Chapter 4 compares and wishes to corroborate the findings of Chapter 2. Twenty working parents took part in the experience sampling study for a period of one week and in follow up interviews. Analysis of participant responses shows that working parents can benefit from automatically updated information relating to availability of each other through the day, support for micro-coordination especially surrounding dinner time and children's activities and getting reassurance regarding the well being of the family. Analyzing the situational variations of information needs we find that parents seek their partner's communication availability during the day, require information to coordinate evening tasks and are prone to exchange information at home rather than at work.

The requirements gathered by the earlier studies brought a clear understanding of the communication needs of this group. To reliably claim that Ambient Awareness systems can satisfy those needs a new awareness system, FamilyAware was developed and evaluated. In Chapter 5, a month-long field study of FamilyAware is presented which allowed ten working couples to automatically exchange place, activity and calendar information as well as messages and photos. The study provides both qualitative and quantitative evidence which strongly suggest that the FamilyAware system can provide support for availability, coordination, reassurance and affection between family members. Findings which inform the design of such systems are: (a) people's need for information about transitions in places instead of location information to support coordination, (b) the two tracks of daily communication of busy parents being reassurance and emergency, and (c) usability barriers in current mobile applications which prevent this group in engaging in photo sharing. Moreover, the contexts and unexpected uses which participants found in the system are described in detail.

Finally, in Chapter 6 concluding remarks about the overall process followed and the results found in the previous chapters are discussed and summarized.

# CHAPTER 2: BUSY FAMILIES' AWARENESS NEEDS

"Man is by nature a social animal", Aristotle

#### 2.1 INTRODUCTION

This chapter<sup>2</sup> examines how developments in the area of pervasive and ubiquitous technologies can support family communication. More specifically, it concerns a class of systems that support sustained and effortless communication between individuals or groups enabling them to build up and maintain an understanding of the activities of each other. Such systems are often discussed as 'awareness systems' and their intended role is to allow connected individuals be aware of each other's activities. Awareness of others, it is hoped, can provide a context for one's own activities (Dourish and Bellotti, 1992) or a trigger and context for making communication through existing media more frequent and rich (Romero et al., 2007).

Interest in awareness and systems that will support it spawned from research in Media Spaces in the eighties and nineties (Bly et al., 1993). Media Spaces are communication applications that support sustained video and audio-links between connected parties. The first experiments with such systems concerned office environments. Interest in awareness systems for domestic and social use grew around the turn of the millennium, as the adoption of Internet and mobile telephony in the Western world became widespread. Below we consider some of the most influential works that considered how awareness systems can support family communication.

An early exploration of awareness systems for the home environment was the Digital Family Portrait (Mynatt et al., 2001). The design concept proposed by this project, involved presenting awareness information about a lone elderly to their children, using a digital picture frame. Awareness information would be presented symbolically using graphics decorating borders around the picture of the remote elder. The project evaluated alternative ways to visualize various types of awareness information. It concluded that the information required for day-to-day awareness of an elderly relative falls into a few general categories that include health, environment, relationships, activity and events.

At about the same time, the Casablanca project (Hindus et al., 2001) proposed two classic concepts of simple and lightweight means of communication between households: The "Intentional Presence Lamp" a lamp controlled remotely by a connected household through which remote individuals can signal to each other their presence at home and the "Scan Board" which enables two households to share a writing surface.

A plethora of related design concepts have followed since, exploring different settings and proposing a variety of means for connecting closely related people. Sometimes this involves supporting

<sup>&</sup>lt;sup>2</sup> Chapter 2 is based on the article: Khan V.J. and Markopoulos P., Busy families' awareness needs, 2009, International Journal of Human-Computer Studies, Volume 67, Issue 2, pp. 139-153

intentional communication acts, as with the Presence Lamp, and sometimes using more background and automated ways of obtaining information about a person's activities, as for example with the Diarist system (Metaxas et al., 2007). This system creates automatically a journal of an elderly person's daily activities (presence at home, going for a walk, cooking, sleeping, etc.) from data collected through a wireless sensor network installed at his or her home. It then presents this information graphically (both instantaneous presence information as well as the journal contents for the past 24 hours), in an interactive photo-frame placed in the home of the elder's child.

As this field evolves, there is a growing interest to go beyond simple visualization prototypes and simulations of parts of the system function, to build and deploy fully functional awareness systems and let families use them for some period of time. The motivation driving such field trials, has been to uncover latent and unmet communication needs that such systems may address, to see whether these systems are likely to be used at all by families as part of their daily life and if so what communication patterns arise.

The InterLiving project (Hutchinson et al., 2003) developed simple mono-functional but flexible appliances ('technology probes') to support intra-family communication that they deployed for sustained periods of time in order to study usage patterns and appropriation emerging in actual use. Their "MessageProbe" enables members of a distributed family to communicate by posting digital Post-It notes on a shared electronic writing surface. Their "VideoProbe" connects households with a camera and a video display that help capture and share impromptu images among members of a distributed family.

A trial of the MessageProbe for six weeks with three U.S. families and several months with one Swedish family and a trial of the VideoProbe for short time with two French families showed that coordination and playfulness are two communication needs that have not been sufficiently addressed by existing communication media. Coordination was particularly important but difficult to achieve with the media at their disposal. It was needed for practical things like picking up the children and getting together for activities. The need for playful interaction was observed with both probes in the form of simple, spontaneous games and making faces.

The ASTRA system (Markopoulos et al., 2004) explored the use of sharing daily experiences with a related household, by constructing a 'to-tell' list, a list of messages and still photographs that are shared as triggers or prompts for a conversation through another medium. ASTRA was a system partly running on a mobile device that supported picture taking and freehand drawing and writing, to create and send a message to an interactive display placed in the living room of a related household (e.g., the households of two adult brothers and sisters). A one-week field trial involving two household-pairs and 13 individuals found that busy families can benefit from the flexibility of this medium, engage in playful patterns of communication, and will not experience increased affective costs relating to unmet expectations, unwanted obligations to communicate or feeling watched over by others (Romero et al., 2007).

Rowan et al. (2005) extended the original Digital family portrait with context sensing capabilities and evaluated it with a field trial involving an aging parent and her adult son. The system comprised of a sensor network deployed at the elderly person's home which gathered information about her whereabouts and activities and then presented that information via a photo-frame placed at her child's home. The level of general activity as evidenced by sensor firings at the parent's home was mapped to the complexity of the graphics shown on the border of the photo-frame at the son's home. A diary study was carried out to analyze the use of the appliance by one elderly woman and her adult son for a period of 4 weeks. The son appreciated being able to monitor his mother's well being without causing undue concerns to her. Also, he used the system as a way of spotting unusual events in the life of his elderly parent. On the other hand, the elderly parent said that the system made her feel less lonely, thus validating some of the motivations behind this design.

Another significant study in this field concerned the design and evaluation of the CareNet Display (Consolvo et al., 2004). This was an ambient display that helped local members of an elder's care network provide her day-to-day care. On the display users could get an overall picture of the elder's condition. The information they could view was about the medication, outings, meals, activities, mood, falls and calendar of the elderly. Data collection was simulated manually and obtained by calling the elder three to six times per day. Members of four care networks of elders (13 people in total) living at home participated in a three-week long field deployment study. During the deployment study displays were deployed to each network at a time. All participants were interviewed before and after the deployment. Researchers concluded that the display had an overall positive effect on the stress levels of the care network of the elderly and that it raised awareness about the elder's daily life.

More recently, Brown et al. (2007) deployed and evaluated their Whereabouts clock; a system targeting the needs for household members to be aware of the location of each other through the day. The 'clock' was an appliance hanging on a kitchen wall, concealing a computer display through which awareness information of the whereabouts of family members was presented. The information they provided was very coarse, distinguishing between 'home', 'work', 'school' and an unlabelled region (meaning 'elsewhere'). The clocks were installed in five family homes (26 people in total) for a period of at least one month for each family. Their deployment and qualitative interviews explored a range of usage patterns for the Whereabouts clock, and concluded that such coarse location awareness of other family members can support:

- Coordinating activities; what the authors describe as 'put the kettle on' behaviors, e.g., knowing that mom is about to return home dad makes sure the kettle is on when she gets home.
- A sense of reassurance; confirming known or assumed location of another party, reassured family members that things are as normal and as they should be.
- Expressing identity; some participants used their reported location as a way of identifying and expressing activities to others.

• Expressing affection; several messages were sent to the device expressing affection.

The research reviewed above is slowly collecting mounting evidence of the benefits awareness systems can bring to families, and the sometimes surprising uses people find for them. The strength of the studies reviewed, especially the most recent ones, is that they examine actual deployment and use of awareness systems for some time (ranging from one to a few weeks), lending a lot of realism and face validity to their results. These studies have focused on a very small and specific set of awareness information that the prototypes tested support and a very small sample of users. In trying to gauge the potential of awareness systems it becomes necessary to triangulate such longitudinal but small scale field deployments allowing for a broader consideration of the types of awareness that might be needed by families and by surveying a larger sample of users that will allow some more general conclusions to be drawn.

More specifically, looking beyond any particular design concept, it is important for the further development of this field to answer the following research questions:

- Do families want to be aware of each other through the day as is implicitly assumed in this field? Would they perhaps rather not know about each other's whereabouts?
- If they do wish to have some awareness, what should they be aware of? The question 'aware of what' posed as a central question for research in awareness systems by Schmidt (2002) still needs to be answered in the context of family communication.

The field studies reviewed above provide positive evidence regarding the first two questions. However, the evidence they provide is not unequivocal. In most cases (with the exception of Romero et al. (2003)), use of a system was not compared to non-use, and do not address the question whether awareness information is wanted at all. Further, these studies are restricted to location information, so it is not known whether similar positive results hold for other types of awareness.

A critical issue in this research field is how to achieve a balance between what information people would like to know about others or, conversely, to make known to others. It is clear that there is a trade-off between trying to address the need to communicate and the need for privacy, but it cannot be taken for granted that this extra level of connectivity and information disclosure between family members is something they need or want.

Consolvo et al. (2004) gathered empirical data by using several methods (privacy questionnaire, interview, experience sampling, voicemail diary) examining the value of location awareness and disclosure patterns relating to location information. One of their conclusions was that most of the time (77%) people want to disclose their exact location. Their participants did not find it necessary to obfuscate their location. Although a good proportion of participants (24%) reported to disclose their location imprecisely, they also argued that they did so for the benefit of the party receiving information.

In Khalili and Connelly (2006) participants were students. The study used the Experience Sampling Method (Kubey et al., 1996) to find out what information would people share with another person that is calling. During the study participants carried a PDA and throughout the day every participant received queries prompting to choose what context they would like to disclose to a potential caller. The caller was specified by the researchers. Based on Olson et al. (2005) the researchers chose six distinct categories of social relations between caller and receiver. These included: Significant other, Family member, Friend, Colleague, Boss and Unknown. Although in the context of sharing context information when receiving a phone call, the answer for question A above would be positive. They mention: "70% of participants reported they were willing to use a service that publishes their context information comparable to the one used in our study if their cell phones were equipped with it and if they were provided with a toll to manage their privacy preferences". Moreover, disclosure rates were high with "company" at 74.3%, "conversation" at 69.4%, "location" at 47.4% and "activity" at 46.4%. Especially with the "significant other" (i.e. spouse or partner) disclosure rates were at 76%. Another interesting finding was that "males shared significantly more location information than females for each one of the social relations". An interesting question that arises is whether similar results hold for family communication and whether they do also hold when people experience such awareness systems in actual use. Apart from knowing what people do not mind disclosing, an important question that remains is what information they want to share with their families and, conversely, what they want to know about them.

In this chapter three studies are described that aimed to answer the previously posed research questions in their general form, triangulating three research methods: interviews, a field trial of an awareness system connecting parents and children and a survey conducted over the web. Before the details of the studies are given, we first discuss the need for supporting family communication and explore some of the user needs and sensitivities that are specific to this domain.

#### 2.2 SUPPORTING COMMUNICATION NEEDS FOR BUSY FAMILIES

The research reported hereby focuses on "busy" families with children. i.e., families with two working parents and with children who go to school and follow extracurricular activities. Such a busy lifestyle that is common in many modern societies leaves little time and energy for intra-family and inter-family communication (Sellen et al., 2004). Although existing media cover a number of family communication needs, they sometimes create affective and cognitive costs and leave other needs unfulfilled, like sharing every-day experiences and "small news" reminds of interesting moments and experiences to talk about (Markopoulos et al., 2003). We are interested both in communication between parents as well as communication between parents and children. As noted by Brown et al. (2007), the auxiliary nature of awareness information has to be stressed. For younger children, parents may find it problematic to find out what children experience throughout the day, what problems they face, or even what their achievements and joys are.

Technological solutions that stimulate and facilitate parental involvement in children's lives can be very useful; this can provide important benefits to families and children especially. For example, Bauch (2001) reports the use of a voice-mail messaging application between parents and teachers. The system aimed to increase and improve the communication between them. In this system teachers at the end of the day reflected on the learning experience of their students to a voicemailbox recording a 60 to 90 second voice message. Parents were then able to call the system and select the mailbox for their child's teacher and hear the teacher's message. After listening to the message, parents had the option of leaving a response message. This system resulted in a steep increase of information exchange between them, leading to a reduction of school failure and an increase in the number of students who became eligible for academic honor. This case suggests the potential benefits of the deployment of modern communication technologies. While voice-mail was shown to have a lot of potential it requires an explicit effort by the teacher that is hard to sustain and so is the case for other explicit and direct means of communication. Automatic or semi-automatic capturing and communication of context could provide an implicit way of communication between these two stakeholders. Arguably, providing awareness information effortlessly can scale up and facilitate the involvement of parents in their children's lives. Challenges lie in what content should such systems exchange, how it will be used and what type of privacy concerns arise.

#### 2.3 INTERVIEW STUDY

As a first step to assess the relevance of awareness systems for families we conducted in-depth interviews aiming to understand communication patterns of busy parents, the content of their communication, how their communication embeds itself in their daily routine activities and uncover unmet communication needs.

#### 2.3.1 PARTICIPANTS

The study involved in depth interviews (N=20) with parents recruited via mailing lists of the Eindhoven University of Technology and Philips Research. All informants were Dutch; sixteen of them had young children fitting exactly our targeted user profile i.e., families with two working parents and with children who go to school and follow extracurricular activities. Four had children of older ages, but were included in the study nevertheless to enable contrasts to be drawn during the qualitative analysis of the interview data. Informants had an average age of 40.5 years (31min – 52max), average years of marriage: 12.05 (4min – 28max), average number of children: 2.05 (1min – 3max). All were working either full or part time. There were 8 men and 12 women. Half had a high level of education (Masters/PhD) while the other half had more basic education (high school, college). Some of them were able to work for a day during the week at home as well as some had infrequent business travel to a different time zone.

#### 2.3.2 INTERVIEW PROCESS

Two researchers ran the interviews independently and exchanged notes after each of these. The interviews were semi-structured. They lasted approximately one hour and were audio recorded. The interview commenced with an inquiry into specific communication events and activities during a

recent weekday. The researchers used a common interview guide. In that all the questions were noted according to the flow of the interview. The first question in the guide asked the participant to describe his or her previous day. Then the interviewer analyzed each incident and prompted to find out whether that was a typical daily activity. Furthermore, the interviewer focused on and analyzed communication events. For example, a question in the guide included *"How do you decide if it is a good time to communicate with your partner?"* and *"Can you describe a case when it was a wrong moment to communicate?"*. The interviewer did not strictly stick to the guide in case he had follow-up questions. The interviewer probed into exceptions and regularities for this day and the specific communications, trying to unravel an account of lifestyle and daily communication patterns.

#### 2.3.3 ANALYSIS METHOD

Data was analyzed qualitatively (Lindlof and Taylor, 2002), following some procedures introduced with Grounded Theory (Strauss and Corbin, 1990). Interviews were fully transcribed; statements were segmented and coded to allow tracing back to the interviewer, the interview session and the interview question. Interlysis, an application which was developed to help analyze the data was partly used for the data analysis. Interlysis is described in Appendix I. Open-coding was done collaboratively by the two interviewers using paper print-outs of each segment and categories were created using affinity techniques. Disagreements were resolved on the spot by discussing the disagreement in place and trying to find a compromise to the issue. The emerging categories were elaborated in vignettes, and linked back to the raw data using a custom made software tool. The results are presented below.

#### 2.3.4 RESULTS

#### 2.3.4.1 FEAR OF INTERRUPTING

Communications between busy parents during work hours were classed as interruptions to each other's work activities. Concerns about interrupting each other are a theme that came up repeatedly during interviews with the parents. While at work informants reported to resent interruptions, unless for an urgent matter, as they wish to concentrate on their work.

They refrain from initiating communications with each other for fear of interrupting their work, unless for an emergency or a change of plans. Contrary to our initial expectations, parents did not report as much a need for directly communicating affective communication, e.g., to indicate that they think of each other, or to display affection over the phone. However, in most cases parents use a practical reason to communicate as a pretext for a richer, more affective communication. This is consistent with earlier findings, as for example reported by Romero et al. (2007).

#### 2.3.4.2 COMMUNICATION NEEDS

We identified several reasons that parents have for communicating during the day. We have clustered them in the following categories: coordination, reassurance and responding to emergencies, exchange of experiences and support in new family situations.

#### 2.3.4.2.1 COORDINATION

Coordination between parents concerns mostly children's activities. We saw this theme repeating between different parents. The issue is making sure their schedule does not conflict with planned activities of the children. These activities could be either every-day activities, like going to school, weekly-activities, going to an out-of school activity or special occasions like going to a birthday party of a friend.

"Micro-Coordination" when returning from work to home has a goal which is to ensure/organize what was commonly referred to as "quality time" in the evening. "Micro-Coordination" has been identified as a need by Ling (2004). For parents quality time is mostly time spent with children, playing, reading, having dinner together, etc. The parent arriving last and still aiming to catch some of the activity coordinates how to fit in the schedule with the other parent at home. Micro-Coordination then can be carried out by a phone call before leaving the office or a mobile phone trying to synchronize arrival at home with the evening activities.

Coordination around children can involve other people as well, especially for unusual circumstances or emergencies. In one case parents asked the help of other children's parents acquainted to them, whereas in another parents asked the help of grandparents. One participant comments: *"Yeah, sometimes in an emergency situation we have to come up with a solution at once and then we have to discuss it with parents of other children and we ask if she can go with them after school."* 

Coordination about future family activities whether face-to-face or mediated can take place at any time: during the morning, the evening before, some days before. The chosen timing is influenced by how important the activity is considered to be.

Participants reported that calendars or/and agendas are important means of sharing information. The importance of calendars is previously mentioned in the literature (Crabtree et al., 2003). All sorts of family activities will be written on the family calendar. A participant mentions:

"Of course we have to plan things, because otherwise if we both have an appointment or whatever yeah, we have to find a babysitter. At home I have a, maybe I haven't told you, also a calendar from school that all activities from the school, holidays plans all those things are mentioned on the school holiday calendar and this is also what I use for our private things. So both of us we write that <her husband> goes here or not, so that is also a kind of medium that we use. Very important! I cannot do without that."

#### 2.3.4.2.2 REASSURANCE AND RESPONDING TO EMERGENCIES

A general conclusion drawn from the data is the overriding importance that working parents give to staying aware of the wellbeing of their children. For example, parents purchase communication devices for the children in order to keep in touch with them, and they mention they are always interruptible for them during working hours. Being in touch and being able to react in cases of emergency are two important needs for parents.

#### 2.3.4.2.3 EXCHANGE OF EXPERIENCES

Parents also express they like to exchange positive experiences with their partners and children. In the words of a participant:

"I would be more interested in a system that I could see for instance my children doing for the first time this or that."

#### And another excerpt:

"It depends on what she did this day. But I will ask about the things she went to. She will also tell about the things I didn't know other things that came up. About the things bought something new in a shop which is nice she wants to show it to me and something for the house or clothes and then I will say "yes it is very nice"."

The importance of sharing experiences right at the moment they happen was also emphasized with the design of the ASTRA system (Markopoulos et al., 2004).

Moreover, parents highlighted the need to share experiences in special situations that involve strong emotions. For example, after a job interview, after a very challenging activity at work or when a really bad experience had occurred. In the words of our participants:

"But if I am just with my work... during normal... I would say no (about sharing activity) it's more the exceptional periods that there is something going on and we need the reassurance from each other. But that's not the standard."

And another excerpt:

"For example a month ago, he is a lorry driver and he went driving on the highway and something came that cracked his window shield. So he was much impressed by that, he called to me."

#### 2.3.4.2.4 ADAPTING TO NEW SITUATIONS FOR THE FAMILY

As mentioned earlier, parents do not contact their partners or other family members frequently when they are at work. However, some of them remarked this changes if the family is facing a new situation to which they are not used to, such as an illness of their child or business trip; or adapting to a new life style like new job, pregnancy, new born baby, moving to a new house.

Among the families we interviewed one couple, who had a young child and the wife was pregnant, explained it was difficult to maintain their earlier patterns of communication because they had to arrange too many practical issues to which they were not accustomed.

Another example was of a couple in which the grandfather had recently died. They decided it was better for the grandmother, to live closer to their family. Thus, the parents besides their job and family were helping the grandmother to move in town and arrange all the financial affairs for her. That fact initiated more communication between the parents.

Parents on business trips do not contact their family as frequently as they wish because of time difference and busy schedules. Their priorities are to let the family at home know they arrived safely and if possible they like to be kept up to date with activities back home and give an impression of their own whereabouts at the distant location.

#### 2.3.4.3 SEPARATION OF HOME AND WORK

Contrary to all this evidence regarding the need to stay aware of each other, parents described consistently the need to have a clear separation between family life and work. After leaving their work, participants want to switch their mind to the family sphere. Evenings at home are a busy time, during which they multi-task with most activities related to caring for the children and interacting with them, despite that they often have to bring work back home. The next morning, once out of the house they also want to 'switch their mind' back to work and devote themselves to it.

#### 2.3.4.4 PARENTAL INVOLVEMENT

Parents cherish the relationship between them and their children. Caring for the children clearly came out as a central motivation for family connectedness. Wanting to be involved in their children's lives emerged as a category of particular importance, influencing the behavior, communication and awareness needs of the working parent throughout the day. This view was presented by participants who had young, dependent children.

Increased parental involvement is recognized to provide benefits for the development of children, both socially and academically (Blanchard, 1997; Hoover-Dempsey, 2005). There have been several attempts to support communication between parents and children and to inform parents of school activities. For example, the use of voice-mail to support communication between teachers and parents by Bauch (2001) discussed earlier in this chapter.

While such a direct system such as a voice-mail has a lot of potential it only supports communication between teacher and parent and it requires an explicit effort by the teacher. This kind of effort may be hard to sustain over longer periods of time and to scale up for a large number of pupils. Awareness systems connecting parents to their children through the day could address this limitation, by supporting the semiautomatic capture of relevant information and its use as a complement to extant communication channels, including face-to-face communication or even voice-mail.

#### 2.3.4.5 SKEPTICISM REGARDING AN ALWAYS ON CHANNEL

While many statements of interviewees suggested the need for awareness and sharing information for activities through the day, parents were very skeptical regarding an 'always on' awareness display. For example, interviewees suggested that when at work they might prefer not to have information they cannot react to (e.g., if their child is missing them) or that the constant availability of information about their children might distract them from their work, disturbing the boundaries they try to maintain between their work and their private lives.
# 2.3.5 CONCLUSION

The interview study identified several communication needs for busy families. They need to coordinate, share experiences regularly, to be reassured regarding the well being of each other, to respond to emergencies, etc. Awareness is centered on children, whether this means being informed of their whereabouts or adjusting the day plan to optimize the time spent with them and for them.

Parents appeared very skeptical of the concept of awareness systems: a continuous trickle of information about each other was found distracting and violating a desirable separation between home-life and work-life. This result of course is based on self-reported attitudes expressed outside a specific context and without reference to a specific technology. Interviewed parents found it hard to relate to the concept of awareness systems so we felt that exposing parents to using a system comparable to the class of systems we envision would provide richer and more reliable outcomes.

# 2.4 FIELD DEPLOYMENT OF AN AWARENESS SYSTEM FOR PARENTS & CHILDREN

It was felt necessary to triangulate interviews with other research methods that are more sensitive to context and that refer to a realistic experience of using awareness systems. This was especially important since one result from the interview study concerning the low acceptability of a continuously available awareness display, sheds doubt upon the whole notion of awareness systems for family communication and seems to contradict the positive experiences reported in field trials of awareness systems in a range of studies in this field (discussed in section 2.2 as related work).

We set up a simple awareness service for parents and their children during a two week long field trial. While we do not suppose that the specific system tested is the solution they require, it embodies some important characteristics of the type of systems we are interested in and as such serves to solicit relevant reactions and opinions from them. This was evaluated with a field deployment involving eight parents and five children, lasting two weeks.

The study aimed to answer the following questions:

- Is there a need for parents to have awareness information during the day about their children?
- Is such a system perceived as disruptive?
- Are such systems perceived as privacy-threatening for the children?

# 2.4.1 PARTICIPANTS

We recruited five families from an international school fitting the profile of "busy parents". More specifically we looked for participants that:

- Were married or cohabiting
- Had at least one dependent child

- Both parents in the household worked a minimum of 20 hours a week
- Had children between the ages of 6 and 10

We covered all of our requirements except the third. Three of the couples we recruited had only one member who was working full time whereas the other did not work, in total five children and eight parents (three couples and two parents) took part in the research. The children were ten years old studying in the 7th class of an international primary school in Eindhoven. They were fluent in English. It was a culturally diverse group consisting of one Korean, one Taiwanese, one American and two British children. The average age of the participating parents was 43 (sd=4,2); they had been married on average 13,8 years (sd=2,6) and had on average 2 children (sd=0,9).

The participants were highly educated and held higher than average positions of employment. We can distinguish two groups of users among participating parents. The ones that used the system in the office (4) and the ones that used it at home (4). The four office users were fathers and the four home users were mothers. None of the participants worked at our university (TU/e).

# 2.4.2 PROCESS

First, we held a briefing session at school where we handed the software for the PC application, the week before the trial. At least one of the parents for each child attended the briefing session where we presented background information to the research, introduced the study and answered questions they had. By handing out the CD a week in advance they had time to install the application, try it out and we could fix any technical problems that were experienced.

We then let parents experience the prototype for one week. At the end of the first week parents were asked to complete a short web questionnaire. At the end of the second week we interviewed the parents. We analyzed those interviews qualitatively.

#### 2.4.3 MATERIALS

#### 2.4.3.1 CHILD AWARENESS SYSTEM PROTOTYPE (SCHOOLAWARE)

The prototype, which we named SchoolAware, had three main components. First, was a small Bluetooth headset device. Participating children were asked to turn this on and keep it in their pocket every morning. They carried this device till the end of the school day and then turned it off and left it in the class so that they could turn it on and carry it again next morning. This device was used to solely determine their presence in class.

Next, we installed a PC with an Internet connection and a USB Bluetooth dongle, at the classroom, running XP SP2 and our software<sup>3</sup> which queried every minute for the presence of the children's

<sup>&</sup>lt;sup>3</sup> The prototype application running at the PC in the classroom was developed with C#. For querying the Bluetooth devices we used OpenNETCF. It was compiled for Windows XP.

devices. After querying, our prototype made a record in a database server at the university<sup>4</sup>. Along with the almost-real-time presence information about children the database contained information regarding their daily schedule.

The client application for the parents queried through http the database server at the University and presented the information to the parents' desktop. We also developed an alternative solution for the parents' in case they could not install our prototype. This was a dynamic web page presenting exactly the same information. We preferred parents to install our prototype in their desktop so they would not associate this awareness service with a website or another web service. It actually turned out that only one parent who had a Macintosh could not install the software. This parent used the alternative web application.

In SchoolAware, parents could view three possible images. These are shown in Figure 2. By moving the mouse over the image parents would see more detailed information about when the last check was made by the PC in the classroom. It was developed to always 'float' on top of other windows on the desktop (see Figure 3). Using two buttons parents could minimize or close it.

# 2.4.3.2 DATA COLLECTION

#### 2.4.3.2.1 WEB QUESTIONNAIRE

Parents were asked to complete a web questionnaire which contained five questions. The questions were:

- 1. How would you rate your experience with the system?
- 2. Why did you rate your experience with <answer of 1st> in the first question?
- 3. Did you feel that using the system influenced your conversations with your child? (If yes, why? If no, why?)
- 4. What information were you missing from the system?
- 5. How do you think your children feel about the system informing you about their activities in this way?

Question 1 was closed and had a five-scale item from "Very Bad" to "Very Good". Questions 2, 3, 4 and 5 were open. Participants were asked about their first week's experience, if they felt the system influenced their conversation with their child, what information was missing and how the child felt about it. Along with the parents we interviewed the children participants too. The purpose of having this questionnaire was twofold: To get insight to the participants' experience halfway through the trial and to anchor the final interview with the answers they provided.

<sup>&</sup>lt;sup>4</sup> MySQL was used as the database server.



#### Figure 2: Graphical presentation of awareness information



#### Figure 3: Screenshot of a parent's desktop

#### 2.4.3.2.2 INTERVIEW

Families were interviewed after two weeks. It lasted approximately 30 minutes and began by discussing their response to the web questionnaire. This was followed by an open discussion about usage, feelings and the overall experience of the system. Both participating parents and children were present. Children were asked about their experience of the system as well as if they felt their privacy had been compromised. It is noteworthy to mention that although we interviewed the teacher who was responsible for the class we chose not to present this data since we wanted to exclusively focus on the communication needs of parents and children. The responsible teacher liked the idea and was very much involved since he wanted to help research studies. Through him we found out that other teachers were quite skeptical about such a system, since they felt that their privacy might be violated and their activities misinterpreted by parents.

## 2.4.4 RESULTS

The web questionnaire proved to be relatively useful. The system was rated by three participants as "Neutral", two participants as "Good" and one participant as "Very good". The participants who rated

it as "Neutral" felt neither irritated nor enthused by it. They expressed the need for more detailed information in terms of the child's presence and the child's activities. The participants who rated it as "Good" liked the fact that they were able to know the time schedule and the child's presence in school. One participant mentioned the system influenced her conversations with her child as now she could ask her child reasons for not appearing in school hours. Parents also raised the concern of their children disliking such a system due to feeling that their privacy was comprised. It is noteworthy to mention that two couples reported in the web questionnaire that their child was excited by her parents' involvement and was actually the one who was checking on whether they were using the information she was providing.

Interviews were transcribed and analyzed qualitatively focusing on finding evidence relating to selected themes.

#### 2.4.4.1 ON DISRUPTIVENESS

Contrary to the interview study, participants in this field trial did not experience any concerns or disruptions resulting from the continuous availability of awareness information. When participants were asked if it was disruptive they mentioned that this was not the case. In the words of a participant: *"it was no more demanding than a ping from an email or a PDA or another website, it wasn't sufficiently big"*.

On the other hand, office users complained about the space the application took on their screen. This was especially so for laptop users who were compelled to minimize it. Once minimized it was forgotten. The fact that screen space is important for work use denotes the need of having a separate device (e.g., a photoframe, or a physical output device) for providing awareness information.

Home users noted the system was not disruptive. Their home computer was used only intermittently and having this application running was a reason for the users to check the information this application was providing. For one participant, checking the system regularly became habitual for the short time of the field study. Whenever she was in the kitchen, she would peak at what was going on in the class of her child.

#### 2.4.4.2 ON PRIVACY THREAT

Participants did not report any privacy concerns. When explicitly asked, both children and parents responded negatively. A child participant mentioned: *"it just felt normal"*.

On the other hand, parents thought that if children were older there would indeed have been privacy concerns raised. Their view is in agreement with Caughlin and Petronio (2004) who argue that children have loose privacy concerns before adolescence. Indeed, the study by Fraser et al. (2006) involved participants in their adolescence, who experienced serious privacy concerns regarding family communication.

When children were asked if the device created a feeling of being "looked over the shoulder" they unanimously said that this was not the case. Even three of them, on some occasions, forgot that the Bluetooth device was in their pocket and carried it back home. This shows that the device easily fitted their routine and was not something bothering them. In their words: "I didn't even feel it was on me", "I totally forgot about it".

# 2.4.4.3 THE FEELING OF INVOLVEMENT VERSUS THE FEELING OF SURVEILLANCE

The study was also positive regarding the feelings of involvement in children's lives. In the words of one participant who was a home user: "*it actually stirred the spirit of involvement rather than the spirit of surveillance and I didn't expect that*". This particular participant liked the fact that the child felt that the mother was more involved in her life.

Moreover this same participant reported that the system helped in posing more meaningful questions to the child about her day based on the schedule information. This participant's observation was that the child would easier respond to questions:

"I always ask them about what happened at school but you sometimes get a word or nothing. If I would ask something like: "what was science like today" it kind of focuses them (referring to the child) cause otherwise the day becomes blur"

Another unexpected observation of the same couple was that they became more sensitized to their child's need to communicate with them. Their child would ask at the evening if they had checked the system and asked them for more details about the way it was working.

# 2.4.4.4 AWARENESS INFORMATION THAT COULD ADD VALUE TO AWARENESS SYSTEMS IN A SCHOOL CONTEXT

Higher precision information would be generally appreciated. Detail regarding the exact location of the children. One of our participants put it very eloquently: "half the story is worse than no story at all". This was a comment we received by all participants. Nevertheless, participants expressed a concern; they did not want to have information that would make them worry without the ability of reacting, e.g., if the system would show that there was a scheduled outdoor activity whereas the child was sitting in class. Such contradictory information might create a tension as it would make the parent feel worried. This observation seems to confirm the interview study. In light of these statements, we believe that an important acceptance factor for awareness systems is how they impact upon the accountability of parents and teachers, and whether they create new concerns and responsibilities for parents who could be expected to react to awareness information shown to them.

An exception to not wanting to have to react to what is displayed to them concerned the safety of the child, e.g., they would want to be informed when the child leaves the school periphery unattended. This was expressed by several participants. One home participant who was checking the prototype

every day would welcome a "red icon" among the grey and green. That red icon would denote danger. Note though that the same participant added that such a system might be a solution for the school rather than the parents.

Another participant stressed the need of having richer social information regarding "special occasions". These occasions would include school assemblies, happenings and generally social activities. One more participant wished to be able to observe the social dynamics between the participating children during the day. Another parent mentioned that she would check the prototype when there was a break scheduled because she wanted to be sure her child was out (presumably) playing with other children rather than sitting inside the classroom. It seems observing social interactions between the children are a pronounced need for parents; based on current findings it seems to apply to younger children.

# 2.4.5 DISCUSSION

Awareness information is valued by parents and the reservations expressed in the interview study are largely dispelled. An important consideration for designing awareness systems is their information content: parents expressed the need for more detailed and rich information about their child.

Reflecting on the differences between this study and the interview study we need to note the participants did not feel that the system was interrupting them from their work activities. However, they were concerned about not being able to react in case they received information that would alarm them. Thus, this finding of the field study brings more detail into the reasons parents are concerned of an "always on" system. Another difference between the interview study and the field deployment was the attitude towards an always on system. In the interview participants were skeptical about that concept whereas in this field study most participants recognized value in having such systems in place.

A limitation of the field trial was that it could only provide feedback regarding the availability of a specific (small) set of awareness information. To understand the potential of awareness systems, one has to examine more systematically what information users want to share with each other. Through the interview study we had insights of the types of information that parents would have liked to share with each other however the interview study was open and did not specifically aim to find out what exact information would parents be interested in sharing. The next section reports a survey set up for answering this question.

# 2.5 SURVEY

The survey presented was aimed at finding which awareness information busy parents value about each other and, secondly, to examine whether information flow should be symmetric or not. Social translucence (Erickson and Kellogg, 2000) has been proposed as a way to describe the symmetric needs for transparency and accountability between users of communication systems. Hong and Landay (2004) discussed minimum information flow asymmetry as a way to ensure privacy protection

between connected individuals. Despite that such works have a strong logical and theoretical motivation but as yet, the argument for symmetry in awareness systems has not yet been demonstrated empirically. Most (if not all) research prototypes discussed in the section on related work are essentially asymmetric.

#### 2.5.1 PROCESS

Aiming to construct a set of descriptors for awareness information that a system could provide between family members we surveyed related research literature including papers on the topic of awareness systems published in the following conferences in this field: CHI, CSCW, Mobile HCI and Ubicomp. The collection of these conferences provided an up to date and rather comprehensive coverage of the research field, and captured developments not always published in an archival (journal) format. We included only papers describing systems and system concepts published between 1996-2006.

In each case, we examined the essence of the information that the awareness system was intended to communicate abstracting away from how this information was collected or presented. For example, Cadiz et al. (2002) described in their paper Sideshow, an awareness system that displays among other information traffic conditions at a particular location in the city. This is displayed on a PC based application. For our survey we retained only the fact that traffic conditions are communicated. Thus the statement we formed is presented in Table 1.

The review included 16 papers. Overall awareness information seems to cluster around the repeating themes of location, availability, presence and activity descriptions. In addition to the literature review, we added statements regarding information needs of busy parents that we obtained from the transcriptions of the interview study described above.

In total we derived 41 statements describing awareness information that can be shared between busy parents (the complete list of statements can be found in Appendix II). This list is not complete in any way, as one might be able to dream up an infinite range of information types, at different levels of details and referring to different aspects of people's lives. Rather, it is taken to represent the range of possibilities explored in this research field as well as the ones explicitly reported by our informants to be relevant to them.

Note that it is different to actively wish to share information and not minding if others view it. Consequently, we asked participants to rate each of the above statements using the following scale: *I* want, *I* don't want but *I* don't mind, *I* don't want. The *I* don't want but *I* don't mind scale might initially sound bizarre. However there might be cases that someone would not mind sharing information and at the same time someone would want to receive this information, or the other way round.

Table 1: Example of two information statements, one for sharing and one for receiving which were formed based on the review of related literature			
Share	Receive		
My spouse is informed about the traffic conditions near the location I am	I am informed about the traffic conditions nearby the location my spouse is		

Exchanging information implies both sharing and receiving. For each of the types of information identified in the 41 statements above, we asked a question regarding the willingness to share and a question regarding the willingness to receive this information. Just to give an example of a statement, we had a statement for information regarding traffic at the location of the partner. Someone might be interested in sharing or receiving that information. Therefore we had to phrase a statement for sharing and a statement for receiving. The example is shown in Table 1.

The questions about sharing and receiving can be asked disjointly or conjointly. For example, we could ask "How willing are you to share this information?" about the statement: "My spouse is informed about the traffic conditions near the location I am" and then "How willing are you to receive this information?" about the statement: "I am informed about the traffic conditions near the location my spouse is". Alternatively, we can ask this question about the compound statement: "I am informed about the traffic conditions near the location my spouse is and my spouse is informed about the traffic conditions near the location about the traffic conditions near the location my spouse is and my spouse is informed about the traffic conditions near the location I am".

Asking disjointed questions allows an asymmetric information flow whereas the conjoint question on sharing and receiving suggests a symmetric information flow. To examine whether attitudes of partners are influenced by an assumed symmetry or not, we split participants asking half of them two questions (separately about sharing/receiving: disjoint) and the other half one question (conjoint).

We created an online application which assigned participants to each condition. The assignment of participants to each condition was counter-balanced. Also, the application presented the statements to the participants in randomized order and recorded their ratings.

# 2.5.2 PARTICIPANTS

Sixty-nine respondents were recruited through advertisements placed at an online forum for parents as well as by sending email adverts to secondary schools. Thirty-four of them saw the statements in two steps (for receiving and for sharing) as explained previously. Thirty-five of them saw the statements in one step as explained previously. The order, in this case, both within a statement and overall was randomized.

# 2.5.3 HYPOTHESES

The study had two hypotheses:

- H1: Couples asked in a way representing an asymmetrical exchange of information will be more willing to exchange information than when asked in a way representing a symmetrical one.
- H2: There is inherent asymmetry in information flow of busy parents (i.e. spouses are willing to receive more information than they are willing to share).

#### 2.5.4 ANALYSIS

For questions phrased disjointly (implying asymmetric flows), the willingness to share was obtained by the logical conjunction of one parent wanting to or not minding to share and the other partner wanting or not minding to receive the information. For example, if a participant rated the statement: "My spouse is informed about the traffic conditions near the location I am" with "I don't want" (logical False) and for the statement: "I am informed about the traffic conditions nearby the location my spouse is" with "I want" (logical True) then the result of the logical conjunction would be False.

For each statement, we calculated the proportion of participants choosing to share it (those stating *I want* or *I don't want but I don't mind*). For each statement we then calculated whether the two proportions differed significantly using confidence intervals (with confidence level at 95%).

For testing the second hypothesis we looked at the disjoint group and checked for each of the 41 statements how many of the 34 participants showed symmetry and how many asymmetry. For example, for statement 1 (*My spouse is informed that I am a few minutes idle behind my computer*) we found out that 68% of participants showed symmetry compared to 32% who showed asymmetry. Symmetry in this case would be that this 68% of participants were either willing to share and receive this statement or were not willing to share and receive this statement. Assymetry in this case would be that this 32% of participants were either willing to share but not receive this statement or were not willing to receive this statement. We compared these two proportions for each statement using confidence intervals (with confidence level at 95%).

# 2.5.5 RESULTS

For all 41 statements there was no significant difference found between the proportions reported when assuming symmetric or asymmetric information flows, so H1 cannot be rejected. Thus, this means that we cannot conclude on whether attitudes of partners are influenced by an assumed symmetry or not.

H2 was rejected for each and every of the 41 statements representing awareness information. Thus, this means that there is an inherent symmetry of information flow between busy parents. Therefore, busy parents are willing to share the same information that they are willing to receive.

#### 2.5.5.1 CONTENT OF INFORMATION EXCHANGE

We were interested in the statements that emerged to be most and least wanted to be shared and received. Least wanted awareness information was represented by the statements in Table 2. They seem to represent too detailed and specific information. Considering information parents do not mind sharing (Table 3) they also seem to be very specific and detailed and two of them are related to computer activity. On the other hand (and this is what we would expect based on the previously mentioned finding) parents seem to be interested in sharing broader information like how they are feeling and if they do not want to be disturbed (Table 4).

Table 2: Awareness information parents want to share the least (N=69)	
My shouse is informed about the general noise level of the room I am	
in	44%
My spouse is informed that I am a few minutes idle behind my computer	47%
My spouse is informed about what the title of my next meeting is	50%

Table 3: Awareness	information that most	parents do not mind	sharing (N=69)
			J ( ) (

My spouse is informed that I am logged out from my computer	62%
My spouse is informed that I am having a break	56%
My spouse is informed about my Instant Messenger status	53%

Table 4: Awareness information parents want to share the most (N=69)

My spouse is informed that I am wishing him/her a good day	74%
My spouse is informed that I do not want to be disturbed now	71%
My spouse is informed about how I am feeling today	68%

Least wanted statements to be received are presented in Table 5. One of them is also found in Table 2(does not want to be shared as well). As was the case with sharing information parents do not want to receive very detailed information. The same idea is also reflected with the statements parents do not want to receive but do not mind receiving either (Table 6). They all represent information which is

very detailed. It is naturally not surprising that the statements that parents most want to receive are exactly the same as the ones that parents want to share (Table 7). This again reflects the wish of having symmetric exchange of information.

-	Table 5: Awareness information parents want to receive the least (N=6	9)
	l am informed that my spouse is a few minutes idle behind his/her computer	38%
	I am informed about how many times my spouse spoke with other people today	50%
	I am being informed about what is going on in the room my spouse currently is	50%
-		

# Table 6: Awareness information that most parents do not mind receiving (N=69)

I am informed that my spouse is engaged in an Instant Messaging	50%
conversation with another user	
I am informed about when my spouse is close to the supermarket	50%
I am informed about the medication my spouse has taken during the day	50%

Table 7: Awareness information parents want to receive the most (N=69)

l am informed that my spouse is wishing me a good day	74%
I am informed about how my spouse is feeling today	62%
I am informed that my spouse does not want to be disturbed now	59%

# 2.5.6 CONCLUSIONS & DISCUSSION

We presented an online survey of 69 busy parents regarding their communication needs. Overall we can draw the conclusion that parents are willing to provide and receive awareness information.

Considering the type of information they wish to communicate, it seems that more expressive means of conveying emotions and intentions are needed; high level content and especially relating to feelings is valued more than communicating trivia enabled by technology.

There was no difference found in preferences regarding sharing awareness information, whether a symmetric or an asymmetric system is assumed. For simplicity and efficiency, in future surveys we need only survey the need to 'share information'.

Having found nearly no imbalance regarding the willingness to share or receive information supports the "Principle of Minimum Asymmetry in Information Flow" proposed by Jiang et al. (2002) for designing ubiquitous information systems and the concept "Social translucence" by Erickson and Kellogg (2000). Thus, a design requirement for awareness systems for busy parents would be to allow both users to be able to share and receive the same awareness information.

There are limitations to the method of online surveys, such as not having control of the participants who are answering (self-selection bias) and the often discrepant expressions of attitudes to the actual behavior of people as users. To address these limitations an experience sampling study (Kubey et al., 1996) was conducted and will be presented in Chapter 3, to examine the preferences and attitudes of people as they move in different contexts and engage in their daily activities.

# 2.6 SUMMARY OF RESULTS

# 2.6.1 CONSTANTLY AVAILABLE AWARENESS INFORMATION IS LARGELY APPRECIATED BY PARENTS, THOUGH NOT BY ALL

In the interview study major skepticism regarding an always on display was raised while in the field deployment and the survey study most participants recognized value in having such systems in place. The latter result partly confirm studies of Brown et al. (2007); Consolvo et al. (2004); Rowan and Mynatt (2005); Romero et al. (2007) and Metaxas et al. (2007) which all found evidence of participants appreciating the value of awareness information.

The negative finding might be a result of the way the interview study was run. Respondents were not asked to consider any specific awareness information or any specific situation before judging whether awareness information would be useful. Also, results from the field trial that refer to a concrete and actual experience of a system have to be taken as more reliable than the interview study. An alternative explanation could be that the families surveyed differed systematically with regards to their communication needs. It could be that families belong to different communication types. Koerner and Fitzpatrick (2004) classify families into four categories according to their communication types. The ones that were keen in exchanging information would probably be either *Pluralistic* or *Consensual* (preferring to share experiences and discuss things openly) whereas the ones that were not that keen would probably be *Laissez-faire* or *Protective* (who prefer to keep things private and not

openly discuss matters with other family members). The potential influence of family communication types upon the acceptance of awareness systems is an issue of further research.

# 2.6.2 WHAT DO PARENTS WANT TO BE AWARE OF?

The most valued awareness information concerns were:

- The availability of their partner to communicate
- Daily activities and trivia but only in unusual and challenging family situations and,
- Activity and location information from their dependent children.

These are three conclusions we can trace back in the interview study. The particular group of busy parents has not been investigated under the prism of awareness information needs and therefore these conclusions add to the literature of awareness systems.

Affective communication did not appear as a high priority during the interview study but was found to be an important priority during the survey study. This may be because the interviewee's were not explicitly asked to evaluate whether they need other means for affective communication. Affective communication has attracted the interest of researchers of communication between couples (Brave and Dahley, 1997; Strong and Gaver, 1996; Tollmar and Joakim, 2002; Vetere et al., (2005) who seem to support the results of the survey.

The survey study has provided evidence in favour of the argument for providing symmetrical awareness information to the two parents. This finding supports the concepts of *social translucence* and the *minimum information flow asymmetry*; most experimental awareness systems for family communication discussed in the introduction do not seem to support this symmetry (for example the DFP, Mynatt et al., 2001 or the WAC, Brown et al. (2007)).

# 2.6.3 AWARENESS INFORMATION NEEDS ARE CONTEXT DEPENDENT

In the interview study we found that parents refrain from initiating communications with each other for fear of interrupting their work. However a number of exceptions were raised referring to emergencies, change of plan, wishing to be available for their children, or when having to deal with unusual and changing circumstances as a family. In short, the interviews suggested a lot of variability and context sensitivity to awareness needs.

This conclusion is supported by the field trial; whereas sometimes the prototype was not considered disruptive, parents expressed the wish not to receive information on which they cannot react. In the case of the survey study, there were always statements that participants do not mind to share or receive them. Although we did not ask the participants, it is very probable they rated statements in such a way that they would sometimes want to share/receive them but not all of the time.

This conclusion contrasts the principle characteristic of awareness systems, which is to support a constant flow of automatically assembled information. Those systems do not offer the option to users

to specify contexts where they would be willing to share/receive information and contexts where they would not be willing to share/receive information.

With these three studies we contribute in informing designers of awareness systems for busy families. We contribute in finding what information is exactly needed for this group; we have presented evidence that such systems should be symmetrical in terms of information exchange and we identify specific contexts where exchange of information is particularly important to busy families.

While these three studies brought into light important requirements for the design of awareness systems it was also evident that when researching requirements for systems which aim to communicate context information, the context itself plays a role of great importance. The methods applied in the studies reported in this chapter allow for little consideration of the context. For example, during an interview a participant might describe circumstances under which an event occurred nevertheless memory will certainly bias the participant in remembering in detail the particular context. This reason was the main motivation for considering a more context-sensitive method to apply in order to corroborate the findings presented in this chapter. The most relevant method for this reason is the Experience Sampling Method (ESM) (Hektner et al., 2007).

While preparing the necessary tools to execute the ESM for the purposes of researching the awareness needs of family members during a typical day of theirs, we were faced with the shortcomings of this method. Some of the shortcomings included participant perception of the protocol as tedious as there was a single question that was asked repeatedly, occasions when prompting a query at an inconvenient moment and participants missing in seeing that their input was actually used and acknowledged by the system.

The aforementioned reasons forced a critical reflection of the method and whether these shortcomings could be rebated. This critical reflection brought into light another method, the Day Reconstruction Method (DRM) proposed by Kahneman et al. (2004) as an alternative to the ESM. The idea of borrowing elements of the DRM to rebate shortcomings of the ESM seemed intriguing from a methodological point of view. The methodological aspects of mixing characteristics of both methods were researched and were found to be promising. These promising results and the details of the combination of characteristics of the two methods are thoroughly discussed in the next chapter. Thus, the next chapter provides a refreshing interval in the pursuit of researching the awareness needs in intra-family communication.

# CHAPTER 3: RECONSTRUCTING USER EXPERIENCE IN THE FIELD

"If I'd ask them (customers) what they wanted they'd have said a faster horse", Henry Ford

# 3.1 INTRODUCTION

This chapter<sup>5</sup> presents the methodological aspects of a method which combines characteristics of the Experience Sampling<sup>6</sup> Method (ESM) (Hektner et al., 2007) and the Day Reconstruction Method (DRM) (Kahneman et al., 2004). To execute the method a distributed system called Reconexp was developed. The rationale and concept behind the method, the system and the data analysis which exhibits the potential of the method are described in detail in the following sections.

In the context of the thesis, Reconexp was developed to corroborate the findings of Chapter 2, but then taking into account the everyday context of busy parents. However, while developing Reconexp we were also interested in collecting data to evaluate the methodological aspects which arose. Thus, for the Reconexp study there were two datasets collected with the same group of participants. In the first dataset the log of participants' actions on the Reconexp system was kept and it was used to evaluate methodological aspects. In the second dataset the answers of participants to the experience sampling study were kept and it was used to find out the awareness needs of busy parents during a typical day of theirs. The first dataset and its analysis are thoroughly described in this chapter whereas the second is presented in the next one, Chapter 4.

#### 3.1.1 CHALLENGES AND PITFALLS OF ESM

Although very useful in prompting the reporting of subjective experiences over time and in context, ESM also has its shortcomings such as interrupting the subject from daily activities, asking at inconvenient moments, and the tedious nature of answering the same or similar questions repeatedly. Current research in this field is concerned with improving methods and corresponding tools to improve such shortcomings (Froehlich et al., 2007, Hsieh et al., 2008, Kapoor and Horvitz, 2008).

Such research, aims to address some of the inherent shortcomings of ESM: sampling interrupts informants from their activities, or it inquires at inappropriate moments. Moreover, ESM is expensive; it puts high burden on participants, and provides little information about uncommon or brief events, which are rarely sampled (Kahneman et al., 2004).

<sup>&</sup>lt;sup>5</sup> Chapter 3 is based on the article: Khan, V.J., Markopoulos, P., Eggen, B., de Ruyter, B. and IJsselsteijn, W.A, Reconexp: A way to reduce the data loss of the Experiencing Sampling Method, Proc. MobileHCI '08, ACM 2008, pp. 471-476

<sup>&</sup>lt;sup>6</sup> In this chapter the terms: experience sampling, experience sampling method, experience sampling study and experience sampling tool are used. Experience sampling refers to the act of capturing moments of the life of participants. Experience sampling method refers to the abstract ideas of the research method. Experience sampling study refers to the research endeavor which has applied the method. Experience sampling tool refers to the system developed to support the execution of the study.

Loss of data seems to be a major problem. Froehlich et al. (2006) report completion rate of 80.5% and Consolvo and Walker (2003) also report an 80% completion rate (on average 56 out of 70) with as low as 28.5% (20 out of 70). Even worse, these numbers do not inform the researchers about the significance of the data lost. It is reasonable to assume that the data loss occurs when people are busy or engaged in social or professional activities. These might be precisely the situations that researchers are interested in studying.

On the other hand, the unique advantage of ESM is its ability to capture daily life as it is directly perceived from one moment to the next (Froehlich et al., 2007), providing a rich set of data to researchers.

# 3.1.2 TOOLS DEVELOPED TO IMPROVE SHORTCOMINGS

Related to the growing popularity of ESM as a method, is the development of research tools to support it. Intille et al. (2003) have developed software that enables researchers to acquire feedback from participants only in particular situations that are detected by sensors connected to a PDA. Froehlich et al. (2007) developed MyExperience, a system for capturing both objective and subjective in situ data on mobile computing activities. A common characteristic of these works is that they aim to improve the method by optimizing the choice of when to prompt informants with a question; this choice can be based on previous answers of a participant or on inferences made regarding their activity based on context sensing (see for example, Kapoor and Horvitz (2008)).

#### 3.1.3 METHODOLOGICAL VARIATIONS TO ADDRESS SHORTCOMINGS

An alternative to ESM, proposed by Kahneman et al. (2004) is the Day Reconstruction Method (DRM), which was designed to assess how people experience their various activities and settings of their lives. Subjects in this case are asked to record a detailed diary of activities and events during one day. These do not relate directly to the focus of inquiry of the researcher, which is not disclosed to them at this point, but are meant as a memory aid, a kind of scaffolding, to allow informants to recall and reconstruct the experiences and feelings of the last day during a follow up interview the day after. This is an in-depth semi-structured interview, during which the researcher probes regarding experiences and feelings that the investigation aims to explore. Kahneman produced strong evidence regarding the efficacy of this method; however DRM suffers from low accuracy regarding factual aspects of the experience (e.g., time when events occur, factual details and environmental aspects which are easy to capture with ESM), similar to those of diary studies reported above.

By its nature, DRM is appropriate for short studies. Its efficacy for providing rich and contextualized accounts of user emotions in the last 24 hours is achieved by means of an elaborate interview which is not meant to be carried out repeatedly in a study and is practically difficult to repeat over longer sampling periods. Field studies in the domain of ambient intelligence typically exceed two weeks in duration, sometimes reaching even half a year. For such cases, DRM can help understand only a small

fraction of the activities and experiences of informants, missing out a lot of information regarding the context in which it takes place.

A combination of ESM and DRM has the potential to compensate for each of their complementary weaknesses. Such a combination is the Experience Sampling and Reconstruction Method (ESRM) introduced later in the thesis. According to this hybrid method, participants follow the same procedure as with ESM. Through the ESM procedure, a partially complete data set is created (given the data loss issues discussed above). Furthermore, at regular intervals (e.g., daily) participants are required to complete, elaborate and even reflect on the reported experiences using the partially complete ESM log as a scaffolding. Reconstruction is done partly by completing gaps in the data collection of the day and partly by elaborating and reflecting on this recent data. Crucially, this stage is still lightweight enough that it can be repeated daily for participants. The queries which are missed during the sampling day can then be recovered through an interface with the log.

In Chapter 3, a combination of ESM and DRM will be presented, that was conceived to address the limitations of both methods. This hybrid method will execute ESM and at the same time provide the log created by ESM to enable participants to reconstruct a sampling day. The queries which were not captured during the sampling day can then be recovered through an interface with the log.

# 3.2 EXPERIENCE SAMPLING & RECONSTRUCTION METHOD (ESRM)

ESRM is a combination of Experience Sampling and the Day Reconstruction methods introduced in the previous section. It takes advantage of their complementarities to address their respective shortcomings discussed above. The essence of this hybrid of the two methods is that participants are expected to respond to an experience sampling protocol as with traditional ESM; the set of answers and the unanswered questions are then provided in an editable log that supports recollection and reconstruction of the experiences.

The motivation for the reconstruction is twofold. The first motive is to retrieve data which are lost. It is a well known fact that when conducting an experience sampling study it is inevitable that sometimes participants will be prompted to respond at moments inconvenient for them, e.g., when in a meeting, or when driving, etc. For those moments the experience sampling method fails. It is those moments however that might be particularly interesting from a research point of view. The second motive is to provide a way for participants to annotate the samples taken during the day. By its nature, the ESM requires that responses solicited from informants should be brief to reduce disturbance and encourage frequent reporting. This though can come at the expense of capturing rich and detailed information about the experiences studied. The reconstruction step allows for more comprehensive reporting and more reflective comments to be provided by informants than an ESM protocol alone might solicit.

Contrary to the DRM the purpose of the sampling is clear to participants when they construct the log of activities/experiences; further the sampling and reconstruction activities may take place for long

durations as with ESM. Contrary to ESM, we also collect data post-hoc and allow the elaboration or modification of earlier responses at a time that is more convenient to the informant. This should address potential loss of data of the ESM and recollection problems that may occur with DRM.

The procedure is described below from the perspective of the participant; the required initialization of the application by the researcher is self-evident so it is omitted. The exact procedure has the following steps (Figure 4):

- Personalization of experience sampling protocol
- Combined ESM and DRM data collection
- Debriefing interview

These steps are next discussed in detail.



Figure 4: The steps of the hybrid method. First participants insert information to personalize the experience sampling step. Then the experience sampling is executed and for each experience sampling day participants are asked to review their answer and fill out the data which were lost during the sampling day.

# 3.2.1 PERSONALIZATION STEP

The motivation for having the personalization step is to minimize the time and effort needed for participants to respond to the mobile device when prompted to do so. Of course reducing the effort required is expected to help preventing data loss but also to encourage accurate reporting.

Personalization can mean a few things: adjusting the timing of the sampling procedure, personalizing defaults and choice items offered to the user and thus reducing the effort for entering data. Personalization has several advantages. From a research point of view it enables the researcher to compare the answers given for the personalization step with the experience sampling itself. This comparison can be interesting to analyze since it relates participants' expectations with what actually happens in situ. It also allows more intensive text entry to be done on the website rather than in situ with a pen (an inherently slower and more cumbersome way of entering data). The information thus obtained is used to populate list-boxes offering choices to participants at sampling time. Personalization helps also set some parameters for the sampling protocol thus allowing better timing for the sampling events.

#### 3.2.2 EXPERIENCE SAMPLING AND RECONSTRUCTION STEP

During the day the device prompts participants to enter information as in a standard experience sampling approach. As with all computer supported experience sampling, prompting can be programmatically controlled to occur in regular intervals, at random moments or when some conditions regarding the context and the informant activity have been specified.

The informant can respond by selecting between choices of items describing his/her activity, context or emotions, or even by free text entry to answer more open questions. The information entered on the handheld device is stored on the online database and is available for retrieval and review directly.

The reconstruction step should happen as close as possible to the collection of data through experience sampling, e.g., within 24 hours. It requires the visualization of the experience sampling logs, the ability to edit them and provide extra information. The interaction requirements for the tool support are different than those applicable for experience sampling: whereas mobility and speed of entry of some brief information is the priority during experience sampling, it is now required to have a good visualization, and efficient ways of editing and inputting text, e.g., using a desktop computer. Of course, one could also allow revision and editing of answers for the reconstruction using a small handheld device, but this could be at the expense of obtaining richer and more extensive descriptions from informants.

Appropriate visualization of earlier answers can help informants reconstruct their experiences and provide richer descriptions/information about them. Also important, such visualization can help researchers track the progress of the study, opening up the possibility to adapt the sampling protocol while the study unfolds. Researchers can, for example, provide additional incentives or further instructions if they notice that a particular participant is not responding to the daily queries. It also enables researchers to prepare questions for debriefing interviews while the sampling is still unfolding.

# 3.2.3 DEBRIEFING INTERVIEW STEP

During the debriefing interview participants are asked to reflect upon their opinions to the queries posed during the sampling period. The interview can be utilized to understand in depth the reasons participants responded to the research questions. This step becomes even more useful if the logs of answers are reviewed before approaching each participant. For example, researchers might spot in the log a pattern in the way a participant had answered to a particular question. Based on such an observation the researcher has a unique opportunity in discussing the pattern in detail with the participant. Moreover, the researcher conducting the interview can go through the logs together with each participant and let the participant give further explanations of the underlining reasons behind the participant's answers.

# 3.3 THE RECONEXP TOOL

The "Reconexp" ("**recon**structing **exp**erience") tool was developed to support the ESRM method. It is a distributed application partly running on a Smartphone (from now on mentioned as "device") and partly on a website. This section describes how Reconexp embodies the characteristics of the hybrid method and how we used it for the purposes of our research.

## 3.3.1 IMPLEMENTATION

Currently the application has been deployed on QTek 9090 and HTC Touch P3450 smartphones. QTek runs Windows Mobile 2003 Second Edition while HTC runs Windows Mobile 6 Professional. The Reconexp application has been programmed using Microsoft's .NET Compact Framework in C#, and OpenNetCF libraries for controlling the WiFi adapter of the device. Participant's data are managed using the MS SQL Server CE. Finally the replication features of Microsoft's SQL Server are used for merging data collected with the central database. For the website part, Windows XP was used as platform, Apache as web server, Microsoft SQL Server as database server, PHP as back-end scripting language and the jQuery framework for implementing user interface features (Figure 5).



Figure 5: System architecture of Reconexp. Several mobile devices synchronize the participants' answers to a central database server. The central database server gives access to participants through a website. After being authenticated participants are able to review their answers, annotate them and give answers to queries they could not respond to during the sampling day.

# **3.4 CASE STUDY: SURVEYING COMMUNICATION NEEDS OF BUSY PARENTS**

In the previous section the general method was described. In this section the context of the research is briefly presented and the use of ESRM.

The broader context of this research is family communication and the way pervasive computing would be able to support it. As was seen in the previous chapter of this thesis two facts of modern life seem to put family communication needs of busy professionals into pressure: (1) less time to spend in social communication and (2) having to work in distant locations from their family. Current communication media like mail, instant messaging and telephone are ubiquitous and mostly affordable; however they satisfy those needs only partly because one has to spend time and effort to keep in touch. Initiating a communication often presents a threshold as individuals do not want to disturb others or do not think that a communication is warranted without having to communicate some 'worthwhile' information, see for example Markopoulos et al., (2005).

This study was aimed to investigate the potential benefits but also the potential disadvantages and obstacles to user acceptance of technologies that rely on context sensing to provide frequent updates of the activities and whereabouts of a person to his/her family.

We examine how such technologies can support intra-family communication and more specifically fit the patterns of daily life for "busy parents". In Chapter 2 we defined "busy parents" as individuals who are married or cohabiting, are both working at least part-time and have at least one young, dependent child.

There are several reasons why a sustained and in situ survey of user attitudes is necessary to understand the issues surrounding the automated sharing of awareness information. First, communication needs vary over a day. One might wish to reveal her location only when a certain event occurs, e.g., departing from workplace, but not the rest of the day. The same holds for the recipient's interest in such information; it only becomes relevant at particular times and in relation to specific activities. As we have already presented in Chapter 2 this issue was highlighted during the interview study with 20 busy parents, the field study of a rudimentary PA system and the online survey with 69 participants. The three studies produced results that were sometimes conflicting, and could only provide low granularity of information relating to how participants could assess experiences for a whole week or even in general, outside a specific time and space context.

Initially it was attempted to answer this question using ESM. Appropriate tools were developed to support ESM and a field study was planned. However, during the pilots for this study with two participants and two members of the research team for a period of one week, some of the inherent shortcomings of ESM as discussed above emerged clearly. Pilot participants perceived the protocol as tedious as there was a single question that was asked repeatedly. This resulted in repetitive and uninformative answers. Moreover, there were many occasions where prompting took place at an inconvenient moment and participants could not answer the question. Finally, participants missed seeing that their input was actually used and acknowledged by the system. In light of these problems, the ESRM method was defined and the Reconexp tool was developed.

#### 3.4.1 PERSONALISATION STEP

In the particular study the personalization step had four parts. In the first part participants were asked to choose information that they would be generally willing to share with their partner (Figure 6). In the second part they were asked to name places they usually visit during a working day of theirs (Figure 7). In the third they were asked to name for each place activities that they usually perform while being there (Figure 8). In the fourth and last part they were asked to name information they would be willing to automatically share with their partner while being in a particular place conducting a particular activity (Figure 9). This they had to repeat for each combination of the places and activities they identified. For this last part they could either choose from a short list of the statements selected during the first part or they could name different information statements. The statements of the first part were short listed to the ones they wanted to share with their partner.

### 3.4.2 RECONSTRUCTION STEP

Participants were requested to login to a website and review the log of the sampling each day. Participants would then view a log of the sampling obtained during the day (Figure 11). While reviewing this log participants could fill out missing queries (Figure 12).

#### 3.4.3 DEBRIEFING INTERVIEW STEP

In the debriefing interview participants were asked whether it was difficult for them to remember unanswered queries, what information they thought they usually wanted to share and tried to address other issues they might have had with the whole study. The interview lasted approximately 30 minutes. Due to the fact that it was one researcher who was conducting the whole study and several participants were participating at the same time, it was difficult to thoroughly go through the logs created during the sampling period. As described previously in the interview step of the general method it would be valuable to thoroughly go through the logs and prepare individual questions for each participant according to the participant's answers. Due to the aforementioned reason this was difficult and therefore a recommendation might be to either have more than one researcher executing such a study or have people participating in sequence rather than at the same point in time.

# 3.4.4 PARTICIPANTS

A complication that arose while conducting the study was that some participants had problems synchronizing data. Factors such as firewalls, anti-virus applications or having a proxy prevented 8 out the 20 participants (40%) to synchronize their data and have the opportunity of filling out the unanswered questions posed in the device at the website. Thus the results reported concern 12 out of the 20 participants initially recruited. Out of those 12 participants, seven were men and five women.

The participants' average age was 38 years (max: 44, min: 28, sd = 5.7); they had on average approximately two children (median: 2) whose average age was 5.5 years (max: 8.5, min: 0.7, sd = 2.6). Participants were married on average approximately 10 years (mean: 10.9, max: 20, min: 2, sd = 5.2)

and on average worked close to 30 hours per week (mean: 28.2, max: 40, min: 20, sd = 6.6). Finally, the participant's spouse worked on average also roughly the same hours per week (mean: 30.9, max: 50, min: 20, sd = 8.9).

Participants fitting the profile of a busy parent were recruited through social relations, through a local community group (scouts) and through a participant database managed by the university. All participants were Dutch citizens, married or cohabiting and were thanked with a gift voucher at the end of the study.

# 3.5 USING RECONEXP IN THE RESEARCH CONTEXT

In this section the use of Reconexp for this case study is described. After participants accept to take part in the study, they are directed to the website where they are initially asked to choose what information they would be generally interested in sharing with their partner (Figure 6). We only asked about sharing and not about what information they wished to receive from their partners as was described in Chapter 2 that this particular group is reciprocal to information exchange. Rather than a free text entry, participants could select from an extensive list of different types of information types that is shared through research prototypes described in related literature as well as those mentioned during the interview study mentioned in Chapter 2. In total, we identified 41 seed statements describing awareness information that can be exchanged between busy parents by using an awareness system. This list is of course not exhaustive, as one might be able to dream up an infinite range of information types, at different levels of detail. Further, participants can insert new statements through the website. Items that participants did not select during the personalization step were removed from the options offered during the experience sampling part of the study.

After completing the first part participants are asked to provide information about their context by using the website (Figure 7). By "context" we mean places and activities (Figure 8) participants visit and perform during a usual working day of theirs. In the final part of this boot-strapping phase on the website we ask participants to imagine what information they would like to communicate while being in a specific place doing a certain activity (Figure 9). This list of information statements was carried from the first part of the personalization step. The statements that were chosen as "wanted to" be exchanged and "not minding to" be exchanged were presented here. Participants could add information statements to the list in case they would think of other information that they wanted to share with their spouse in a specific context (Figure 9). Added statements would be presented in the list for all available contexts. We purposely left this final step optional for participants since this would need to be repeated for every place and activity. If for example a participant would have named five places and for each place named five activities then this participant would need to repeat 25 times the last step. That is why we left the participant to choose the most important contexts and link information statements to those only. In any case, those links would be created during the ESM part.

Names for places and activities entered in the website during the personalization phase were restricted to 30 characters to match the limitations of the screen size of the portable device, where the entered names would appear as a drop-down box (Figure 10). This consideration exposes the interconnection of the two parts of the application and how restrictions of the device are posed to the website.

😻 exercise 1 of 2 - Mozilla Firefox			
Bestand Bewerken Beeld Geschiedenis Bladwijzers Extra Help			0
C X 🖓 🔄 C ktp://id00347.campus.tue.nl:81/Reconexp/chooseInf	ormation.php?msg=	Google 🖓 🔹	P 🔍 · 🔒
Technische Universiteit			
Eindhoven			
University of Technolog	y		≡
-			
Dear participant,			
We are researching what kinds of information couples war automatically.	nts to share with each other. In	nagine a mobile device that could help ex	change this information
Please read each statement in the list on the left and	d then click on a radio butt	on to select the statement that refle	ects your preferneces.
Thank you for taking the time to participate in our study.			
For any questions/problems you can always reach us at: <u>v.</u>	<u>j.khan@tue.nl</u> , Javed-Vasileios	Khan.	
My snorse is informed		How willing are you to share this information?	
ny spouse is informed	I want to	I don't want to but I don't	I don't want to
1. about the meals I took today	0	0	0
My spouse is informed		How willing are you to share this information?	
	I want to	I don't want to but I don't mind to [7]	I don't want to
2. whether I slept well today	0	0	0
My spouse is informed		How willing are you to share this information?	
2. about the general noise level of the room I ar	I want to	i don't want to but i don't mind tom	I don't want to
5. about the general hoise level of the room rat	0	0	0
My spouse is informed		How willing are you to share this information?	
to sub-these Terris Alberra	I want to	I don't want to but I don't mind to 🕅	I don't want to
41. whether I am at nome	0	0	0
My spouse is informed		How willing are you to share this information?	
42. whether I am logged out from my computer	I want to	mind to mind	I don't want to
	0	0	0
	Save my answe	ers	
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Figure 6: First part of personalization step: participants choose information statements they would be generally (in any context) willing to share with their partner.

<u>STEP 1:</u> <u>Name common places</u> (up to 5)	<u>STEP 2:</u> Link activities to places (up to 5 per place)	<u>STEP 3:</u> Link information to context
Name Places		
Consider a typical working day. Startin more important for you.	ng from the morning till the end of your day, p	ease name the five places you think are
Insert name of place:	*(max: 30 characters)	
	1	
You have already inserted	d the following places:	
my desk	update	
cafeteria	update delete	
meeting room update delete		
printer	update delete	
informal meeting room	update delete	

Figure 7: Second part of personalization step: Naming places visited on a typical working day.

<u>STEP 1:</u> <u>Name common places</u> (up to 5)	<u>STEP 2:</u> <u>Link activities to places</u> (up to 5 per place)	STEP 3: Link information to context			
Link Activities	s to Places				
Could you please for every place you	a named, name some activities (up to 5 per place)	) you usually do at that place?			
Choose Place: home	×				
Name one activity you do related to t	the selected place: *(max: 2)	30 characters)			
Or choose an activity you have alread	iy named:				
	submit data				
You have already inst	You have already inserted the following activities:				
For place: home you	have already inserted activity: working	delete			
For place: home you	have already inserted activity: resting	delete			
For place: home you	have already inserted activity: watching a movie	delete			
For place: home you	have already inserted activity: cooking	delete			
For place: home you	have already inserted activity: having a friend	delete			
For place: home you	have already inserted activity: watching TV	delete			
For place: office you	have already inserted activity: working	delete			
For place: office you	have already inserted activity: chating and having	g a coffee delete			
For place: office you	have already inserted activity: browsing the web	delete			
For place: office you	have already inserted activity: meeting with colle	delete			
For place: cafeteria	you have already inserted activity: working	delete			
For place: cafeteria	you have already inserted activity: chating and ha	ving a coffee delete			

Figure 8: Third part of personalization step: Naming activities performed on a typical day.



Figure 9: Fourth part of personalization step: Linking information to context, participants can insert additional information statements to the existing list.

After a participant inserted the initial information on the website we synchronized the device with this information and then handed it over to this participant for one week. We requested participants to keep the device in close proximity constantly.

An audio notification alerted the participant when it was time to record information. Then the application (Figure 10) gave the participant five minutes to respond to three questions: about the place where the participant is at the moment, about the participant's current activity and about the information the participant would like to automatically exchange with his/her partner.

Activities and information statements were adapted according to the previous answer. For example, if a participant would answer that he was at his office the next question would present him with the activities he named to be doing while being at the office. For every question presented on the device, the participant had the option to answer "Other". If a participant would choose "Other" then for the next question possible answers were not short-listed. For example, if a participant would choose 66 "Other" as a place then we would present him with all the activities he named for all places in the next question. For the last question if the participant did not check any item from the list, this would be recorded as "Nothing", meaning that the participant did not want to send any information to her/his partner at all.



Figure 10: The three questions posed at the device (top part of the screens). The drop-down lists in the first two screens and the checkbox list are populated by the personalization step.

Furthermore, we asked participants to place the device in its cradle in order to synchronize the data at the end of every day during the sampling period. After synchronizing the data we instructed the participants to log onto the website to review the data (Figure 11). While reviewing participants could fill out omissions of the experiencing sampling obtained during the day on the device.

There were actually two kinds of omissions that the participant could correct at this stage. Answers as "Other" (if for example she was in a place that is not covered in the existing places presented in the drop-down menu on the device) and unanswered questions. When a participant fills out an omission, for example names a place which she left unanswered when asked on the device, then this new place is added to the list of places she has made during the personalization phase. This new place will also be present on the mobile device when the participant synchronizes the data. We also instructed participants to annotate their answers while reviewing them. We were interested in the reasoning behind the participants' answers.

At the end of the week we conducted the semi-structured interview described in section 3.5.3. It must be clarified that in the case where we had couples participating, the information inserted by a participant was not communicated to other partner.

#### 3.5.1 SAMPLING PROTOCOL

The sampling protocol combines time based and event based sampling. First, we check when the last answer of the participant was given. If that was more than an hour earlier, we query the participant. However, if that was between 30 to 60 minutes earlier, we check whether participant has changed place. If that is the case then we issue a question.

To find out whether the participant has changed place we compare surrounding WiFi access points with the stored WiFi access points of his last answer. The formula for calculating the probability of being the same place is:

If in a previously stored place A we have recorded N1 number of access points and if N2 is the number of access points of N1 which were not found in the surrounding access points at the query moment, the probability of the user being at A is:

$$p = \log \frac{(N_1 - N_2) * 10}{N_1}, for \frac{(N_1 - N_2) * 10}{N_1} > 1 \land N_1 > 0$$

We should underline that this formula is just a heuristic that we based on our own experience. Currently it appears that this formula can easily flag when an informant moves to a different building, floor or part of town. This technology is not meant to identify fine grain movements, e.g., more away from and to a desk.

#### CHAPTER 3: RECONSTRUCTING USER EXPERIENCE IN THE FIELD

Day Reconstruction	- Mozilla Firefox				1
Bestand Beyerken Bee	id Geschiedenis Bladwijz	ers Egtra Help	analdan ahabdan dan 200 💳 🔿 🔹	0 🗖 . 💿 🗖 . 🖸	
TU	e Techniso Eindhov Universi	Fe Universiteit en ty of Technology	antioning of a second second		- Days of ES participation
		/∽			particular ES day
Dave: 01-	Apr-2008 02-Apr	-2008 04-Apr-2008	71	EXIT	
Apr 2 2008		¥			- Questions asked during ES
Time Pla	ice	Activity	Information	Comments	Review of answers and
10:58 Thu	3	TV/ontspanning	whether I am at home	Save comment	participant during an ES
12:04 N	ot answered	Not answered	Not answered	Save comment	Participant can annotate specific samples
13:10 Thu	is	Spelen met kinderen	Other -		_Participant can name answers given as "Other"
14:16 No	of enswered	Not answered	Not answered	Save comment	Participant can fill out unanswered queries during the ES day
15:22 Thu	is	TV/ontspanning	Nothing	Save comment	
Klasy .			A 0.50 🔅	X = ( 131, 155, 176, 193 zotero	2

Figure 11: The day reconstruction interface.

		🖉 http://id00347.campus.tue.nl:81/?what=a&id=2&when=Apr 2 2008 🔳 🗖 🔀
13:10	Thuis	Name Activity
		Please name the Activity you were doing on Apr 2 2008 14:16
		<u> </u> 0
14:16	Not answered	Save data Cancel
		т
15:22	Thuis	TV/ontspanning Nothing

Figure 12: "Other" activity can now be named at the website.

# 3.5.2 RESULTS OF THE STUDY

# 3.5.2.1 LOG

The twelve participants' actions which were logged and their occurred frequency are presented in Table 8.

## 3.5.2.2 ANALYSIS

A first inspection of the data suggests that the website was used heavily (Table 8). The total number of performed actions equals 553 resulting in a mean number of actions performed of 55.64 (logins are not accounted in these numbers).

Table 8: Type of participant actions which were logged and their occurrence					
Logged participant action	Occurrence				
Login to the system	33				
Name a new Location which was not answered	11				
Name a Location which was not answered using existing value	155				
Name "Other" Location using existing value	10				
Name "Other" Location	8				
Name a new Activity which was not answered	14				
Name Activity which was not answered using existing value	155				
Name "Other" Activity using existing value	26				
Name "Other" Activity	14				
Name Information which was not answered using existing value	155				
Name "Other" Information	1				
Name "Other" Information using existing value	4				
Total participant actions	586				

Out of these actions 15% were performed in the morning (between 06:00 and 12:00), 22% in the afternoon (between 12:00 and 17:00) and 64% in the evening (after 17:00 till 06:00). These figures confirm our expectations that evening time is the most convenient for participants to reconstruct the data. However this is notably not the only convenient time for participants and actually a rather large percentage of data (46%) was recalled during morning and afternoon.

Furthermore, we observed that participants on average logged in 2.75 times in the period of one week to review the data they had inserted during the day. This means that on average approximately once per two sampling days participants would check their log.

In Table 9 we report the results of the logged data. What becomes evident is that several questions were not answered while using the handheld device (which relates to the sampling component of the method). For example, the mean percentage of non response to the second question ("What are you

active in now?") was 49.41%. However, a significant amount of those (55.38%) were recovered by the use of the website, i.e. via the reconstruction component of the method.

Table 9: Results of logged data				
Description		max	min	SD
Mean number of actions performed				
(logins not counted in this number)	46	155	1	64
Mean logins (in 5 days)	2.75	7	1	1.92
Mean times participants were questioned				
(at least 5 days)	62.58	124	14	27.67
Mean times the 2nd question (about activity)				
was not answered	30.92	65	1	16.8
Percentage of mean number of activities				
(2nd question) not answered:	49.41%			
Mean of percentage of activities recovered				
(through the website)	55.38%	97%	0%	40%
Overall improvement (data recovery) of				
the website to the method is	27.36%			
I OTAL COMMENTS (number of participants who commented: 8 out of 12)	33	4.13	8 15	4.51

It was about one out of two times that participants could not answer when prompted by the device and it was a bit more than half of those that they recovered with the help of the website. When considering answers given for all questions using the device and the website then the overall response improvement of the website to the ESM is: 27.36%. We analyzed the second question posed on the device since there was an equal number of times participants were asked the three questions; the recovery of the data for the other two questions differs only slightly.

A content analysis of unanswered, on the device, places which were named on the website includes among other: "home", "doctor", "train", "fitness", "meeting room", "car". A content analysis of unanswered, on the device, activities which were named on the website includes among other: "housekeeping", "eating", "cooking", "shopping", "check internet", "put coat on", "fitness training", "driving", "reading news". Finally, a content analysis of unanswered, on the device, information statements which were named on the website includes among other: "dinner time", "about when he expects to be at home", "changes in working hours", "if I can bring something from shop", "how late I will be home", "when dinner is ready", "whether I need to use the car", "whether the children are going to play elsewhere", "whether the children are ok".

From the content analysis we first observe that with the reconstruction phase we were able to get the places and activities where the ESM alone would result in omitted responses. Moreover, this content analysis gives insight into the places and activities in which people are not able to respond. It is interesting to note that beyond some expected places and activities such as "car", "meeting room", "eating", "fitness training" for which we would not have expected participants to be able to respond to the device, we observe places such as "train" and "home" and activities such as "check internet" and "reading news" for which participants were not able to respond as well. Thus, the proposed hybrid method helps in providing evidence in terms of the availability of participants for experience sampling studies.

Furthermore, the content analysis shows that reconstruction of places and activities can be extremely precise. In terms of activities for example, the reported activity "*put coat on*" is extremely detailed and we would never have expected participants to recall such a fine grained activity. The data collected however prove the opposite; namely that participants are able to recall fine grained activities. Stated opinions during the interviews corroborate the logged data. The reason we would not expect participants to recall such activities are mundane, extremely typical that one would do without paying any attention or precisely remember when asked for. It is a known fact that short-term memory fades over time and that fact would hold especially for everyday activities such as "putting a coat on".

In terms of recalling events we have both quantitative and qualitative evidence to support that the hybrid method does not pose considerable difficulties in recall. During the debriefing interview we asked participants how difficult was it for them to remember the location, activity and information they would like to exchange when they were earlier asked on the device but could not answer. All but one said that it was easy for them to remember and accurately answer a question they could not answer at the device at the original sampling time. They offered two reasons for that. The first one was that when trying to remember and fill out the unanswered questions they concerned situations that were not too long ago in the past. In all cases except for one they provided missing information one or two days later.

The second reason they mentioned was that the overview on the website was providing them with a frame of reference (which was the motivation for doing so based on the Day Reconstruction Method). For example, when a participant could not answer a question posed at 13:30 but did answer several questions before and after that, these answers would help recall whereabouts, activities and what information this participant would have liked to exchange in such a context.

The results presented in this section raise new requirements for tools which aim to support researchers in executing the ESM. More specifically we presented evidence of the potential of
showing participants a log of their answers as well as giving them the opportunity to answer queries they could not complete during the sampling period. Nevertheless, there are other requirements that such tools should include. To find out what those requirements are, in the next section we review studies which describe the features of tools as well as the researchers' experiences in using them. The section concludes with the requirements which a future tool should encompass to support researchers in executing the ESM.

# 3.6 REVIEW OF COMPUTERIZED EXPERIENCE SAMPLING STUDIES

Apart from being extensively used for psychological studies (Barrett and Barrett, 2001) the ESM has gained considerable popularity among researchers of design aspects of computer systems and especially ubiquitous computing systems. In this section we will review computerized ES studies. Through this review we aim to conclude with properties which an optimal ES tool should have to support researchers in both the fields of ubicomp and psychology.

Pioneering examples of such tools include: PsycLab Mobile, a tool which supports audio recording on a pre-defined schedule (Mehl et al., 2001), CAES (Intille et al., 2003), a pioneer in combining sensor input to trigger queries based on events recorded by sensors, Purdue Momentary Assessment Tool (PMAT), which was developed at the Military Family Research Institute at Purdue University (Weiss et al., 2004) and supports both time based and event based studies and it also provides a desktop application to configure parameters of the ES study and finally ESP, an open-source tool developed at Boston College (Barrett and Barrett, 2005). The latest version (ESP 4.0) includes a suite of software packages, a Palm OS based application that interacts with participants and a PC application for designing experiments, configuring ESP settings, and collecting data which runs on Windows and Linux. Although these tools have been pioneers in trying to support researchers in conducting ESM they nowadays seem outdated and one of them (CAES) has even discontinued and has joined forces with a more recent tool which will be reviewed in the following paragraphs (MyExperience). Thus, for this section, recent studies which have built up on the aforementioned ones are reviewed.

We will begin this review with two projects which have developed tools to integrated aspects of both easily creating ubicomp prototypes as well as evaluating them (Carter et al., 2007, de Sá et al., 2008).

The framework of de Sá et al. (2008) supports both prototyping and evaluation. It provides a log of events taking place on the mobile device and a researcher has also the ability to execute an ESM. It runs in Windows Mobile, Palm OS and Symbian OS devices. The logging engine stores a variety of events. Events range from each tap on the screen, each button press or even each character that was typed by the user. It supports audio and video capture. To analyze the collected data, a log player is provided. The log player resembles a "movie player" which re-enacts every action that took place while the user was interacting with the prototype. ESM can be event-triggered. The framework is public available.

A similar tool, supporting both mobile prototype creation and remote evaluation of those prototypes is Momento (Carter et al., 2007). It was created to support remote testing of ubicomp applications. Momento can also gather log data, experience sampling, diary, and other qualitative data. One of the requirements the researchers found while conducting interviews with ubicomp developers to elicit requirements for their system is the need for integrated tools for annotating and reviewing qualitative data. Momento can run on participants' existing networked mobile devices. Researchers can use a desktop application to configure experimental details, to monitor incoming information from participants, send information to participants and review data or exporting it for analysis. Momento uses SMS and MMS and HTTP (if available) to share information between participants and researchers. It supports audio, photo and video capture and situated annotation of captured media. The mobile client is configured using a text file. Momento can also support the review and annotation of data lost during ES and the developers have not researched the potential benefits of such a feature. A disadvantage is that it needs desktop installation for both client and server and therefore support for troubleshooting and version track management. Momento is open-source software.

MyExperience (Froehlich et al., 2007) has passive logging of device usage, user context, and environmental sensor readings and active context-triggered user experience sampling to collect in situ, subjective user feedback. Queries can be targeted to moments of interest by triggering off sensor readings. Researchers, by using XML, can define survey questions and configure sensors, triggers, and actions. Embedded scripts are used to provide flexibility and expressiveness in specifying the conditions to trigger surveys. MyExperience supports sophisticated survey logic including multiple branching, parameterized questions, and persistent states. It supports audio, photo and video capture. Although it opportunistically synchronizes collected data, it does not provide a web interface for participants to review their answers and fill out the missing queries of the ES part. Even if it is designed to run on participant phones still there are issues with installing it in a Windows Mobile device from our personal experience. Although it has an incredible amount of features it still requires a long installation process. Moreover in the case a researcher wants to have real time retrieval of data it requires to have and manage MS SQL database server with replication features. Another shortcoming is that it requires removal of security lock from the phone which might allow programs such as dialers to run without the users consent. MyExperience is open source software.

Showing participants their own collected information was offered to increase compliance rate. In a 25-day field study, Hsieh et al. (2008) found that users who saw visualizations of their own data were more likely to respond to sampling requests compared to users who did not see visualizations. The compliance rate of those receiving feedback was 23% higher than the rate of those who did not receive feedback. This result suggests that showing participants visualizations of their own answers has a positive effect to the study itself. The researchers do not report the use of any tool for conducting the ES therefore we assume that it was a custom made application.

In their quest to measure and evaluate emotional responses to user interactions with mobile device applications Isomursu et al. (2007) deployed an ES study in which participants answered questions by selecting an appropriate emoticon on the mobile phone's screen. It was a custom made ES tool which allowed both system and user initiated experience recording. It supported event based triggering of queries. Participants could not insert text or any multimedia input. Further, the tool logged user interactions on the mobile device. The tool was running at the participants' phones. Additional comments could not be provided to clarify the answers. One important finding of their evaluation regarding the method was that participants would accidentally press a button and give an unwanted response in situations like driving, or when having the phone in their coat, or in cases that they would receive a phone call. Such a finding suggests that ES tools must support defining inconvenient moments for participants. Having such an option would be beneficial to researchers because they would not collect data which were accidentally inserted and they would not disturb participants with queries during inconvenient moments.

Isomursu et al. (2007) have also created the Experience Clip method. In this method, pairs of participants are recruited. Both of them are provided with mobile phones. One carries the application which is under evaluation and the other is instructed to take short video clips of the usage of the first participant. The participant taking the video clips was a friend of the other participant. Time stamps of the videos were used to match interaction events with the expressions of emotions captured by videos. The researchers conclude that having the users to decide which usage situations to record did not seem to spur versatile and innovative usage. This approach had the disadvantage that it was not clear which captured situations represent real usage situations and which not. They suggest that a combination of the Experience Clips with other non-intrusive methods would perhaps yield better results. This method brings a different perspective into the computerized version of ESM. It advocates the involvement of people in the surrounding of the subject whose experience is sampled.

Commercial examples of such tools include the Pocket Observer and Entyware. Pocket Observer is a commercial tool developed by Noldus (2009). Pocket Observer requires Observer® XT, a desktop software and it runs on handheld computers with Windows Mobile. Further details are not publicly available. Entyware is used to conduct sophisticated questionnaires for a wide range of survey applications, including face-to-face interviews, diary studies and photo diaries (Techneos, 2009). The software provides analysis-ready data in SPSS, Excel or ASCII formats and it runs in both Windows Mobile and Palm OS devices. It provides immediate access to response data that is collected from mobile users. Conducting simultaneous, large scale ES studies is difficult due to the cost of devices and for that reason Techneos, the company which has developed Entyware, even rents devices in North America to provide its customers with a packaged solution.

#### 3.6.1 CONCLUSIONS

ESM tools are useful not only for psychological research but as it was shown from the aforementioned studies they can also be useful for design and evaluation purposes. They can support the elicitation requirements process as well as iterative evaluation of mobile applications. Although there is a

plethora of tools available, most of the studies we reviewed still develop custom-made software to execute ES studies. This means that the few non-custom tools available still lack features that would make researchers adopt them.

Another conclusion important for future ESM tools is the support to provide an interface for participants to give feedback during the sampling period. This property will not only increase compliance rate but it will also recover lost data. Environmental sensor data would be also useful in inferring with greater accuracy the participant's context making the presentation of queries even more sophisticated and even more appropriate.

Furthermore, although some of the aforementioned studies have used synchronization of collected data (Froehlich et al., 2007, Hsieh et al., 2008) none of them gave the opportunity to participants to fill out queries they could not answer during the day.

It seems that there is a need for even easier to develop and execute tools. In concluding this review we would like to sum up the features that an optimal ES tool for researchers to conduct ES studies should encompass.

#### 3.6.2 REQUIREMENTS LIST FOR THE FUTURE ES TOOL

Based on the Reconexp study findings and the review of tools used in research studies a list of requirements can be drawn. The event-triggering of queries, for example when a participant enters a location, is supported by some of the tools reviewed however it is either a built-in function, in the case of Reconexp for example, or in the best case (MyExperience) it is programmable by using XML. Although XML is in many ways easier than programming in C or VB it still requires a certain expertise in markup up languages. Therefore, a requirement for an even more accessible tool would be the even-triggering of queries to be end-user programmable. End-user programming would be much easier to learn and apply when having a plethora of events available to the researcher.

In the reviewed studies tools presented the queries either in the screen of a mobile device or a desktop. However, a participant might have left the device in her bag while she is working in front of her desktop computer. A future tool can certainly include the possibility of smart presentation of queries. More specifically, queries can be prompted in multiple devices, in either desktop PCs or mobile devices, according to which device is more accessible and available to participants.

Support for multimodal participant input has been already included in several tools. Text, audio, photos and video can provide richer data to the researcher (Carter et al., 2007). On the other hand, participants can choose the most efficient and convenient modality for addressing the query.

In the case of CAES, MyExperience and Reconexp among others, user context factors are automatically captured. The location and possibly the activity of a participant can serve as examples.

Automatic capture of participants' context would provide different perspectives for researchers to look at the gathered data and obviously provide more in-depth results.

All of the reviewed tools require extensive installation procedures and in most cases management of database or web servers. In tools that combine mobile phones and desktop PCs installation procedures have to be followed in both devices. This fact brings another obstacle to researchers who lack technical skills. Extremely quick and easy installations on mobile devices and even no installation procedures for desktops would be another important requirement for such tools.

Another requirement is support for optional, user initiated input. In the case of Reconexp, participants could not initiate the queries. That would be useful in cases where participants would recognize the importance, in terms of research, of the context they currently are and initiate the research queries. In that way salient information will be saved.

An important shortcoming of Reconexp was the difficulty participants had in synchronizing the data. Automatic synchronization of captured on the device data to a remote server would both secure the data as well as provide the grounds for feeding the data back to participants as the case with Reconexp was. MyExperience already supports such a feature and according to our experience of Reconexp it is a crucial feature.

Automatic and configurable information visualization tools of the collected data would be a crucial feature for helping researchers disambiguate the data and quickly provide useful results. Alternative visualizations in the form of graphs can enable researchers to view the data in new, fresh ways and provide therefore opportunities in identifying new results. This analysis tool should be able to support visualization of events that occur both frequently and infrequently (Barrett and Barrett, 2001).

Participants might become less motivated during the course of the research study. Programmable by researchers email or SMS notifications to the participants can help to keep participants highly motivated. In addition, support for notifications for researchers when certain events occur would also be of added value (Barrett and Barrett, 2001).

In most cases, ESM tools which use a mobile device force participants to carry another mobile device along with their personal one. It would be even more convenient if such tools would run on participants' phones and provide a seamless experience to participants. In this way larger scale studies could be conducted. It would be less expensive and chances are higher they would actually carry the device on them when prompted to answer. Another possibility would be to remotely recruit participants. However, a researcher would thoroughly need to have tested the tool so that it would not interfere with the participant's device. Moreover, agreements with the mobile service provider must be made in advance so that participants are not burdened with the cost of the service. Therefore, agreements with mobile phone providers must be in place to easily refund costs participant incurred during the study. Another important feature beyond the ability of participants to review the collected data would be the ability to participants in annotating the data and also to fill in the gaps. The potential benefits of such a feature have already been discussed in this chapter. In case researchers need to visually explain something to remote participants the support of video streaming between participant and researchers (video phone calls) would be handy.

Furthermore, mobile devices in comparison to desktops have limited processing and memory. The data collection tool on the mobile device should not noticeably impact the performance of the participant's mobile phone (Carter et al., 2007). If that happens it might affect the results of the study since participants will experience a lag in the presented queries. In a previous study (Carter et al., 2007) it was found that the tool on the mobile device should provide mechanisms to avoid interruptions at inopportune moments. Inappropriate moments will create frustration to participants and negatively bias them in answering the queries. In case where a mobile device is lost, the tool on the mobile device should offer mechanisms to protect the security and privacy of the data (Carter et al., 2007). Finally, in a more abstract level the tool on the mobile device should be accessible by a wide spectrum of participants. Thus, participants should be able to increase the color contrast, the font size (Carter et al., 2007).

# 3.7 DISCUSSION

From a methodological perspective, the case of Reconexp seems to support the rationale of combining the Day Reconstruction Method and the Experience Sampling Method. The Reconexp distributed application clearly reduces data loss and it also streamlines the effort required by participants.

When combining elements of the two methods, one might raise the question if the DRM possibly induces "postponing behavior", i.e. participants might decide to postpone their answer on the device to a later moment at the website. This would mean that the ESM component of the combined method, underperforms in this context and perhaps the accuracy of the data set as a whole is reduced. To eliminate such a possibility, future investigations should aim to compare ESM on its own against its adapted version with DRM inside Reconexp. We should mention that we have not found any evidence of such practice on the part of informants. Although not explicitly asked about it, none of our participants mentioned such a behavior during the interviews. Another issue for future investigation would be whether the total reporting effort required by subjects may be seen as more work than one method alone. If that would be the case it might reduce participant inputs.

One should however note that completion rates with the ESM part of Reconexp were considerably lower than those typically reported in the literature. For example, Froehlich et al. (2006) report completion rate of 80.5% and Consolvo and Walker (2003) 80% whereas ours was approximately 52%. This fact could have been caused by differences in participant groups. Previous studies recruited university students as participants. In our case we recruited people who had young children and were

working. It would be safe to assume that these parents would have less time to respond to an experience sampling study and this is what our results depict. However, as stated before, it could be an effect of the method which needs to be checked in future studies.

When adding the mean percentage of completion rate (50.59%) to the mean percentage of the recovered data (27.36%) one ends up having a total completion rate of almost 78%. At a first glance, this is almost the same as the completion rates reported in the aforementioned studies. This would mean that this method has not added to the data loss of the ESM. However, one needs to keep in mind that this was the first system built to execute this method. Obviously there are numerous improvements that can be done to create a more effective, efficient and pleasant interface and interaction. An example of that is the manual synchronization of data on the part of the participant. One future modification we would like to have is the automatic synchronization of the data through GPRS. When having such a feature participants are required to do fewer steps during the research study. They do not have to connect the device to the desktop go to the appropriate tab in the interface of the mobile device and synchronize the data. More importantly they do not need to remember or be reminded about this step. We also would like to eliminate usability issues of both the mobile client and the website by the use of heuristic evaluation and cognitive walkthrough. Another important function we would like to implement is an automatic email notification for participants. This notification will be sent by the system when it detects long periods of non-response from the participant. We believe that all these changes will generate higher completion rates than the one we reported in this study.

# **3.8 CONCLUSIONS AND FUTURE WORK**

This chapter has presented a distributed platform to support the combination of two research methods for collecting subjective data in field studies regarding experiences and feelings of informants: Experience Sampling and Day Reconstruction Method. The new method is part of a line of research started in recent years to support experience sampling tools with the use of mobile devices and context sensing technology.

Compared to related systems, Reconexp is the only one complementing the use of a handheld device for reporting brief notes in situ, with surveying recollection of informants using a website. Related is the work of Froehlich et al. (2007) who combined ESM with web diaries; note that they have used web diaries as a qualitative supplement to the quantitative data gathered through ESM. Compared to their system Reconexp offers the advantage that it allows participants to review and fill out the gaps created by ESM, rather than just presenting earlier records.

There is ample room to develop this method further. Potential improvements include a more flexible and attractive user interface of the website, a more sophisticated sampling protocol and a more usable and attractive interface on the mobile device. Moreover, the annotation of questions of other types of data such as voice and photos will make considerable improvements to the existing system. The first trial of this tool in our research has proven its value. It has enabled a highly contextualized survey of what awareness information parents wish to share with each other that was not available from other studies (interviews, web surveys and field trials with interviews).

These first experiences confirm the value of complementing the mobile experience sampling tools with data collection on a website, allowing the reduction of data loss and the improvement of the quality of the data collected. Follow up studies are needed to consolidate these methodological results and to effect relevant improvements on the tools.

After having presented the pros and cons of a method which combines characteristics of ESM and DRM, the next chapter presents the findings for the initial purpose which this method was conceived; the awareness needs of busy parents during a typical day of theirs.

# CHAPTER 4: SITUATIONAL AWARENESS NEEDS OF BUSY PARENTS

"In the end, what makes the difference is human intent and human capacity", Kentaro Toyama

# 4.1 INTRODUCTION<sup>7</sup>

The previous chapter presented results and conclusions concerning methodological aspects of a method combining characteristics of the Experience Sampling Method (ESM) and the Day Reconstruction Method (DRM). This combined method is named ESRM. Based on the idea of combining those two methods, Reconexp, a distributed application partly running on a mobile phone and partly on a website, which embodied the characteristics of the ESRM was developed. The data set presented in the previous chapter concerned the logged actions participants performed in the different components of Reconexp and what do those mean for the method.

The second data set collected in the same study reported in Chapter 3, concerned the information needs that busy parents have during a typical day of theirs. This second data set will be presented in this chapter. The data was collected by 20 participants. This was the same group of participants with the ones described in the previous chapter. However in the previous chapter the data from 12 out of these 20 could be utilized since 8 participants were not able to synchronize the data from the mobile device and make use of the all of the components of Reconexp. The data from these 8 participants was kept safely at the mobile devices they used and was aggregated to the data of the rest of the participants at the end of the study. Therefore for this chapter the awareness needs of 20 busy parents, when asked in the context of their lives, are analyzed and presented.

More specifically the objective was to find out what awareness information do busy parents want, or do not mind to automatically exchange with their partner and in what context. A second objective was to contrast the findings of awareness information needs in Chapter 2 with the ones found when participants are asked to take their context into account. The chapter begins by reviewing related literature to motivate the need of taking context into account when studying the communication needs of busy parents. Then the method is briefly recapped. Finally, the results and the conclusions drawn in contrasting the findings of Chapter 2 are presented.

# 4.2 RELATED LITERATURE

A large body of design studies, reviewed in Chapter 2, concerns intra-family communication or communication between couples. These studies range from media for poetic and expressive communication acts (Gaver, 2002) to more functional media for sharing moments through capturing stills (Romero et al., 2007) or even video (Conversy et al., 2003). Where available, evaluations of such systems confirm core motivations of their designers, but leave open more fundamental questions regarding the acceptance of such technologies: Is continuously available awareness information

<sup>&</sup>lt;sup>7</sup> Chapter 4 is based on the article: Khan V.-J., Markopoulos P. and Eggen J.H., An Experience Sampling Study into Awareness Needs of Busy Families, Proc. 2nd IEEE International Conference on Human System Interaction, IEEE 2009, pp. 338 - 343

desirable? What are the needs for awareness people actually have? How is awareness of one's social and family relations used and appreciated once it is available?

In this chapter, we examine whether such automatically acquired awareness information is needed by busy parents, by which we refer to parents who both work more than half time and are raising young children, according to our definition mentioned in previous chapters. More specifically, we try to find out what kinds of information they wish to share with each other through the day and through the week.

In Chapter 2, the field study of the Whereabouts clock was reviewed (Brown et al., 2007). The 'clock' was an information appliance that hung on a kitchen wall and presented awareness information of the whereabouts of family members. The information provided was very coarse, distinguishing between 'home', 'work', 'school' and an unlabelled region (meaning 'elsewhere'). The field study evaluation included the installation of clocks in five family homes (26 people in total) for a period of a minimum of one month for each family. Despite the low resolution of location awareness provided Brown et al. concluded that the system was valued for coordinating activities, giving reassurance, expressing identity and expressing affection.

Field studies of this kind are very valuable because of their contextual nature and because they refer to actual experiences with the technologies under investigation. However, Brown et al.'s results can be criticized on two accounts. Mostly, they attempt to generalize from experiences gained with one specific system to draw conclusions about communication needs. Derived uses of the system are bound by the nature of this one system, and which may fail to reveal actual communication needs not related to the specific design. Second, deploying such systems creates a context in which participants can be expected a priori to use the system as part of their participation in the study. This may create a bias, as participants will find a use for a system because that is expected from them. In this sense, field trials while one of the most valuable research methods in our field, do not provide convincing evidence that proclaimed awareness needs are actual and that they are not already well served by current communication media.

A recent study acknowledges this limitation and has addressed it with a more generic user group of mobile individuals (Sohn et al., 2008). By means of a diary study they surveyed the information needs of 20 people while they were mobile. Their analysis identified 16 broad categories of needs with the top five being: trivia, directions, point of interest, friend info, and shopping. Moreover, the research concluded that when an information need arose, participants addressed it at the time, later, or not at all by "calculating a complex cost function" pertaining to the context sensitivity of information needs.

Taking a user perspective, it is important to test some of the assumptions underlying design works such as those discussed above. In the interview study presented in Chapter 2 it was found that parents do not really want to communicate during the day, refrain from initiating communications with each other for fear of interrupting the other's work, unless for an emergency or a change of

plans. Further, participants did not express as much a need for directly communicating affect, e.g., to communicate affect more explicitly over the phone or email. In contrast, another interview study concluded that family members need awareness of other family members to coordinate, to feel connected and to enjoy a feeling of comfort (Neustaedter et al., 2006).

The aforementioned interview studies demonstrate that interviews and questionnaire based surveys suffer from the limitation that respondents' opinions are solicited out of a specific context and removed from the time where related awareness needs arise. Field research is a way to compensate for this limitation. Sellen et al. (2004) present an ethnographic study of the everyday problems of working parents and identify several problems those people face which can be facilitated through communication technology. Among them are: planning for meals, remembering activities other family members need to do during the day and change of plans during a working day. However, Sellen et al. (2004) did not focus specifically on communication needs that this group has and did not attempt to answer the question whether awareness of each other covers an actual communication need or a technology push for this field.

In order to survey awareness needs between busy parents in a manner sensitive to context but without priming them with a particular system prototype, we conducted an adaptation of an Experience Sampling study. When trying to elicit requirements for systems that will communicate part of the context of a user, that context should be taken into account due to the fact that it shapes the content of the medium. Moreover, in the context of this thesis, such a study would be the best exercise to corroborate the findings of Chapter 2 in which methods that only partly included the context of the user were used.

While focusing on busy families, the findings of this research are of more general interest as they aim to confirm the relevance of social awareness systems triangulating partial evidence found by the research works reviewed in this section.

# 4.3 METHOD

The ESRM method, which combined characteristics of the Experience Sampling Method (Hektner et al., 2007) and the Day Reconstruction Method (Kahneman et al., 2004), and the tools used to execute the study included a distributed application running on smartphone devices and a website as described in the previous chapter. A short summary of the procedure followed will be presented next.

Participants were asked to carry a smart phone on which they could record answers to an experience sampling protocol referring to their needs for sharing awareness information. To address a well known limitation of Experience Sampling, namely that respondents do not answer on several occasions (e.g., because they are occupied by some other activity), our sampling protocol allowed them to review logs of their answers over the past day and fill in omitted details. The Experience Sampling logs (answers but also records of unanswered questions) are presented to users on a website and provide a context and a prompt to facilitate recollection at the end of each day of the

sampling period. The details of the tool and the validation of the method were described in the previous chapter.

On accepting to take part in the study, participants were directed to a website where they could describe contexts of a typical, working day of theirs. By "contexts" we mean locations participants visit and activities they perform during a usual working day of theirs. In the third and final step of this 'bootstrapping' phase we asked participants to enter on the website what kinds of information they would like to communicate while being in a specific place doing a certain activity; they could choose from a list of possible options we provided to them or enter their own descriptions of information they would wish to know regarding the activities of their partner.

The ready-made list of statements was constructed based on a survey of related system concepts discussed in proceedings of the following mainstream conferences in this field (mobile HCI, CSCW, CHI and Ubicomp). This list of statements was the same list used in the web-survey study described in Chapter 2. Conferences were preferred over journals given that they are relatively more up to date and provide a broader cross section of the research field. In each case, we examined the essence of the information that the system communicates abstracting away from specific context capture mechanisms and the presentation medium. For example, Cadiz, et al. (2002) describes a system that displays among other information traffic conditions at a particular location. For our purposes we retained only the fact that traffic conditions are communicated. The ready-made list of statements was constructed based on a survey of related system concepts already presented in Chapter 2. In total we included in this survey 16 papers and derived in this manner 41 statements describing awareness information that busy parents might wish to know of each other.

All collected information (i.e. places, activities and selected awareness information for different combinations thereof) provided on the website was used to initialize the experience sampling application running on a mobile device given to the participants. This information was synchronized to the mobile device to make the mobile part of the study easier for participants. With synchronizing the information participants had to either choose an answer they had inserted on the website or choose "Other". For example, when asked on the mobile device to name the place the participant is, he can choose from a drop-down menu comprising of the places named at the website. If a participant is in a place he did not name at the website he can always choose "Other". We requested participants to keep the device in close proximity constantly. During the sampling period, the application was always in the foreground of the mobile device and participants could not access any other application. The sampling period lasted one week for each participant. Though they could lower the volume participants were asked not to shut down the device and to recharge it every evening. Within three days after the sampling period we had a debriefing interview with each participant. In the previous chapter 12 out of 20 participants were able to synchronize the data collected on the device and therefore only that set was analyzed. However, for this analysis the data have been collected from all 20 participants. The demographic information of the participants is presented in the next section.

# 4.3.1 PARTICIPANTS

Twenty people (ten men and ten women), with an average age of 39 took part in the study. At the time of the study, they had between 1 and 4 children (mean 2.25), they both worked at least part-time and the average age of their children was 7. Participants were recruited through advertisement in a scouts association and by use of a participants' database of our university. Their level of education and their occupation varied widely, though all possessed a home computer and had internet access at home. All were fluent in English but this was not their native language. After the study participants received a gift voucher of small value.

# 4.4 RESULTS

The times when participants received questions will be presented first followed by the frequencies of the recorded places and activities. Then we will present four needs that were identified from the collected data.

# 4.4.1 RECEIVED QUESTIONS

The moment in time that a participant would receive a question depended on the days and timings he had set and then whether he was moving a lot. Participants who showed greater mobility would have received more questions. Moreover, we instructed participants to set the days and timings they would be queried on the device, according to days and timings which they are apart. Apparently from the data we can observer that participants were mainly apart during working days and hours (Monday to Friday for almost all of them) and together during weekends (Figure 13).



Figure 13: Number of questions per part of the day which participants received

# 4.4.2 PLACES RECORDED

Participants named 63 different places (mean 3.15, max: 13, min: 2, sd: 3.34). Since our participants are not native English speakers some of them used a word in their own language with the same meaning. For example, "work" was used by some as "werk", which refers to the same place. Moreover, some participants used a different granularity of words. For example, one participant gave the exact details of his office instead of naming it just "office". Finally, there were differences caused by trivial text input errors. In order to have a more accurate view of the data we collapsed such categories that differed trivially in the ways described. The result of this process was 21 different place names; the ten names selected most frequently are show in Table 10.

Table 10: Ten most frequent places (out of the 21 collapsed places that were similarly named from the 63 original named places)

Place name	Frequency
work	321
home	230
outside / on the road	104
school	51
other	28
friends place	14
market / shop	12
coffee corner	9
city centre	8
parents place	7

# 4.4.3 ACTIVITIES RECORDED

Participants named 194 different activities (9.7 mean per participant, max: 35, min: 3, sd: 8.32) With a similar process as described above, we reduced this set to 73 unique activities (Table 11 shows the ten most frequent).

Table 11: Ten most frequent activities (out of the 73 collapsed activities that were similarly named from the 194 original named distinct activities)

Activity name	Frequency	
working	258	
home activities	87	
walking/going to some place	71	
spending time/taking care of the children	69	
meeting	63	
eating / having something	60	
chat / talk	56	
other	46	
relaxing activities / sleep	42	
e-mail / do something on the computer	35	

# 4.4.4 DO PARTICIPANTS WISH TO SHARE AWARENESS INFORMATION AUTOMATICALLY?

Looking at the response-level data (N=815), we examine how often participants (as a group) selected the option 'Nothing' to the question "What information would you like to automatically exchange now?". The frequency of this answer was 12.2% (max: 82%, min: 0%, sd: 20.79%). Looking at the person level data (N=20) we had only two participants that answered "Nothing" more than 50% of the times they were questioned. One had 82% and the other 55%. The next highest percentage was 24%.

In light of these two results we can conclude that overall participants do want to automatically share awareness information with their partners during a typical day of theirs. The next question to be addressed is what sort of information they want to share.

#### 4.4.5 INFORMATION STATEMENTS

Participants linked 57 different information statements to different contexts and a mean of 31.7 different statements were chosen by participants for the whole period of the study (max: 51, min: 1, sd: 12.32). This number shows that a variety of statements was chosen which means a variety in information needs is needed during a typical week of this group. These needs are presented in the following section. Twelve new statements were inserted by nine participants. All new statements are about practical matters, e.g., someone arrives or departs from home, about dinner plans and about the well being of children. Dinner again, as it was found in Chapter 2, stands out as the most important family activity. The fact that participants inserted only twelve new statements indicates that the enumeration of different awareness information types derived from the literature review was

found sufficiently relevant for most of the participants. Nevertheless, participants did not give a precise name to 84 'Other' statements. These 84 'Other' statements could have been different kinds of information statements or could have been same with the statements that were already available to participants. Considering the most chosen information statements, these are presented in Figure 14.



Figure 14: Frequency of chosen information statements

# 4.4.6 INFORMATION NEEDS OF BUSY PARENTS

#### 4.4.6.1 AVAILABILITY

Considering the total set of responses, the two most frequently chosen statements concern availability (Figure 14). Moreover, 19 out of 20 participants chose at one point during the study the

statements: "whether I am available for communication" and "whether I am available only for urgent calls" (Figure 15).



Figure 15: Number of different participants choosing a particular information statement at any time during the study

The main reason mentioned during interviews is for planning direct communication. In the words of a participant: "I filled out a lot about 'can I be contacted' for not so important and important things". They fear interrupting the partner's work flow so awareness information could help them infer the availability of their partner. Yet, there is another social reason for wishing to have availability information. During one interview a participant told us: "For me it is more important (getting availability information from the partner instead of sending) since he is much more busy and it would be embarrassing when trying to call at a wrong time".

A reservation regarding constant connectivity mentioned by some participants was that they did not want to give the impression to colleagues that they constantly want to communicate with their partner. They thought that such an image was socially inappropriate. This issue of maintaining one's professional image at work is important for those participants.

#### 4.4.6.2 MICRO-COORDINATION OF DINNER

As it was found in the interview study of Chapter 2 and corroborated in this study, coming back home and preparing for dinner is a family ritual which is important for communication purposes too. Statements such as "about the location I currently am", "about when I leave my workplace", "how late I will be home", "about when I am close to the supermarket" were also frequently selected. With the help of the interviews we came to know that these statements are linked to participants coming back home from work and preparing for dinner. Surprisingly, when we produced a graph of how many different participants chose a particular statement at any time during the study, the only statement that was chosen by all participants was *"Whether I am home"*, suggesting the relevance of related applications for announcing presence at home (Figure 15).

Having additional information from the interviews, we can conclude that this is connected to the dinner ritual. In the words of a participant: "Also for coordinating, for example if I am close to a supermarket and when I am at home. It is important for us, for our children to have dinner at 18:00 so it is important for us to know when someone is leaving office and coming to home or when someone is already home and what is the expectation time." This activity is perhaps the most salient one during the day for the family and most of the information currently communicated at least an hour before that time is to coordinate that activity.

This observation along with the frequencies of the statements: "how late I will be home" (30), "about when I leave my workplace" (33), "whether I am at home" (22), "how late I plan to leave" (12), "when dinner is served/ready to eat" (10) illustrate how parents value awareness that will help coordinate that activity.

#### 4.4.6.3 REASSURANCE: "NO NEWS IS BAD NEWS"

Statements with relatively high frequency are: "whether I picked up the children from school" and "whether I left the children at school". Through the interviews we found out that whether "everything is going as planned" is important for them. It seems that there is an implicit schedule in mind for both parents of all family members. In the words of a participant: "it (referring to her choices of information during the experience sampling) is generally about practical matters such as bringing the children, the shopping list, mostly in the morning if everything went ok with the children". There is a need of gathering information on whether this schedule is progressing as planned and especially the children's plan. Therefore, one could say that "no news is bad news" in the case of busy parents. Moreover, one of the twelve new statements inserted by participants was: "whether the children are ok". This confirms the need identified by Brown et al. (2007). Moreover, Neustaedter et al. (2006) used the term "comfort" to describe such need.

#### 4.4.6.4 COMMUNICATING AFFECT

We also observe that affective information has markedly lesser priority. In the interviews, the need of information around practical matters was stressed and no mention of a need to share expressions of affect through mediated communication was mentioned. Participants did mention that any interesting aspects at their day are communicated back home in the evening. Although down played in the interviews the statement: *"that I am wishing him/her a good day"* was occasionally selected during the experience sampling. The frequency of selection of this sentence is an indication that one cannot totally exclude that the need for affective communication might arise at specific contexts and times.

#### 4.4.6.5 THE NEED OF "OTHER" INFORMATION

The option "Other" was chosen 84 times (out of the 815 queries) however by only 7 participants. We expected that a lot of those statements would be renamed using the web site in something more meaningful. Only one participant renamed a single statement.

Based on the interviews we can explain the relatively high frequency of "Other" statements on two accounts. The first is the phrasing of statements. Some seed statements did not reflect exactly the information a participant wanted to exchange at a particular point in time. Quoting a participant: "You had in your study 'dropping the children to school' but for us it is more important to 'pick up the children from school'. And that statement we missed in the study". Others mentioned that they missed different types of information such as mood. In the words of a participant: "In the beginning of the study I had a bad day at work so at that day the "mood info" would be interesting to send".

The second reason that was verified during the interviews is that participants did not wish to spend the time to rename those statements as we requested, despite that they did return to the website to provide answers they had omitted giving.

#### 4.4.7 SITUATIONAL VARIATIONS OF INFORMATION NEEDS

#### 4.4.7.1 COMPARING PLACES WITH INFORMATION EXCHANGE

We also wanted to find out the places that participants wanted to exchange most information at. To find that out, we calculated the following ratio: the total number of information statements chosen at each place divided by the number of times they were asked when being at that place. "*Other*" places which probably refers to variety of different places, appears high on the list. However the total times when participants answered "*Other*" as place is quiet low. It is also noteworthy to mention that the differences between the ratios are not large. Furthermore, it would be interesting to observe how these ratios would turn out when the times asked at each place would be equal. For example, it might be when those same participants would be asked 300 times instead of 51 times while being at school what information they would like to exchange that the ratio would turn out to be greater than the one observed in our data (Table 12). As expected it is when parents are "*outside / on the road*" when they want to exchange most information however "*home*" is where people want to share information with their partners rather than while being at work.

Place	Statements chosen	Times asked at place	Ratio
outside / on the road	62	104	0.60
home	120	230	0.52
other	14	28	0.5
friends place	7	14	0.5
work	151	321	0.47
school	22	51	0.43

Table 12: Places which participants wanted to exchange the most information

This could be a by-product of the sampling method. It is harder to provide an answer when on the move or when working. Given though that participants had the option to compensate for unanswered questions at the end of the day, we can conclude that at home there is indeed a pronounced need to share contextual information with the remote partner.

Table 13 shows the five most frequently selected types of awareness information per location (looking only at the three most frequently chosen locations). We note that at home and when outside variable awareness information is needed; availability, activity, affection and location information are all high on participant preferences. At work the five most frequent statements are about availability and activity. When being on the move availability, location and activity information were most often selected.

#### 4.4.7.2 COMPARING ACTIVITIES WITH INFORMATION EXCHANGE

We drew a similar table to Table 13 to examine what information types participants wish to share for the three most frequently reported activities (Table 14). It appears that availability is what they most wish to share while working. The category activity was most often indicated for sharing when performing household activities and location when someone is on the move.

However, in all three activities the same three types of information rate highest and these are availability, location and activity. Moreover, we observe that the sole statement which appears in all three most frequent activities was "whether I am available only for urgent calls". The same case was in the three most frequent places. Those two facts underline its importance.

w	work (321) home (230) outside/on the road (1							04)
	whether I am available only for urgent calls	59	J	whether I am busy	24		about the location I currently am	29
	whether I am available for communication	57		about the schedule I have for today	20	1	whether I am available only for urgent calls	23
	whether I am in a meeting	44		whether I am available only for urgent calls	19		whether I left the children at school	15
	whether I am busy	27		that I am wishing him/her a good day	17		about when l leave my workplace	12
	whether I can be accessed by telephone right now	27		whether I am at home	17		when I am driving the car/bicycle/motorcycle	12
	Location		A	ctivity	Availa	ıbili	ity Affection	

#### Table 14: Five most frequent statements of the three most frequent activities

working (258)

#### home activities (87)

# walking/going to some place (71)

					•		
whether I am available for communication	44		whether dinner is served/ ready to eat	9		about the location I currently am	15
whether I am available only for urgent calls	42		about the activity I am currently doing	5		how late l will be home	9
whether I am in a meeting	31		about the schedule I have for today	5		whether I am available only for urgent calls	8
whether I am away from my office	23		whether I am available only for urgent calls	4		about the activity I am currently doing	7
whether I am busy	23		whether I am away from my office	3		whether I am busy	6
Location		ļ	Activity		J	Availability	

Next in frequency comes general activity and schedule information. The statement "whether I am away from my office" appeared a few times when participants reported performing home activities. Initially this might seem unexpected. It turned out that this was chosen by people whose home activities included working at home.

#### 4.4.7.3 COMPARING TIME WITH INFORMATION TYPES

To analyze the information needs compared to the time of a day during a week we created Table 15. In this table we first chose the three most frequent statements for each part of the day and day of the week. Then we color coded them according to what they were representing; black represents location, dark grey activity, medium grey for activity and light grey for affection.



When analyzing the statements in that way we observe that the chosen statements in the mornings and afternoons of the weekdays are mainly about availability and partly activity and less about location (Table 15). Thus the most salient awareness information is that which would assist parents to infer the availability of their partner during the day. On the other hand, the evenings vary more in terms of information needs.

We observe that for evenings, location is the most prominent along with activity. Thus the need for information to infer availability during the day time (morning and afternoon) shifts to information that would help parents coordinate their evening. This is aligned with the variability of information wanted when someone is at home. Evening time is spent at home for almost all our participants.

Table 16: Mean number of different statements wanted to be exchanged per day/time									
	MON	TUE	WED	THU	FRI				
Evening (17:00–06:00)	0.47	0.48	0.53	0.47	0.65				
Afternoon (12:00–17:00)	0.33	0.25	0.25	0.26	0.14				
Morning (06:00–12:00)	0.29	0.36	0.35	0.39	0.18				

The fact that more variable information is wanted during the evening relates to another observation. Participants reported to want to share awareness information most often in the evening and the least in the morning (see Table 16). In this calculation we included "Other" statements and obviously excluded "Nothing" statements. Combining this finding to the aforementioned finding that coordination is the main communication need in the evening we can conclude that in order to coordinate parents are seeking more variable information. In terms of awareness systems, that means different pieces of information are required to help parents coordinate for evening activities.

# 4.5 DISCUSSION & CONCLUSIONS

Earlier works regarding systems that can enhance intra family awareness often assume that family members will be willing to share information about their activities and whereabouts, and will be interested to receive such information about their partners. The experience sampling study reported here has put this assumption to the test, leaving up to the participants to decide what kind of information should be shared and without making specific the nature of the system that would enable this sharing.

The experience sampling study targeted working parents of young children. Looking at the total set of responses and also looking individually at the reported preferences per participant we obtain a clear result that awareness information about each other that a system would provide automatically is very much needed.

Apart from confirming the interest in the application domain of systems that can support awareness between family members, the study has given us insight into to the types of information that such systems should capture and communicate.

On the limitations of the study, the plethora of different names participants gave to places and activities with the same or similar meaning made it imperative to categorize those under one label. In the case of places the number of different names participants provided was not high and therefore it was not such a difficult task. On the other hand, in the case of activities the sheer number of different

activities made the categorization task time consuming and in some cases difficult. Furthermore, although in most of the cases the categorization was obvious, i.e. one participant named a place as 'werk' whereas another participant named a place 'work', there were cases in which categorization was not that obvious. For these cases in which we were hesitant in placing either a place name or an activity name under a certain category we opted for leaving the place or activity name as a separate category. Moreover, in one case implicit knowledge of the research was crucial in interpreting the name given to a place by one participant. This participant was a teacher in a school. Thus, in her case the named place 'school' actually meant the place she was working rather than the place in which she would drop and pick up her children.

The described limitations were difficult to foresee before the study. These limitations however, can be addressed in several ways in future similar studies. One way would be to have a predefined list of general places and activities and force the participants to choose mainly from this list. Another option would be to let participants first name their places and activities, as occurred in this study, and then ask them to categorize these according to general ones. An alternative could be to ask participants to first name their places and activities and then ask them to type a short description of them. Based then on the description the researcher could group them in high level categories.

When addressing the information needs which were observed it can be concluded that the need for affective communication is rather low compared to the need for practical information such as availability. This is likely to relate to that our target population share the same roof and see each other daily, so they do not need to rely on communication media for affective communication. Rather, it is the need to share practical information that is their highest concern. The aim of this chapter was to compare and to put into test the findings of Chapter 2. The research presented in this chapter investigated the awareness needs of busy parents under context whereas in Chapter 2 the research methods which were used were not that context-sensitive. The interview study in Chapter 2 showed that the need of communicating affection in a mediated way was not interesting for busy parents. On the contrary, the web survey showed the opposite. In this chapter we observe that our participants were not interested in statements to communicate affection in a mediated way. Therefore we can conclude that it is the interview study findings which are corroborated and not the web survey study in which affection proved to be the most wanted statement to be exchanged. The reason that affection was so profound in the web survey study was most probably due to the nature of the method. The web survey is disconnected from a particular context. Perhaps during the web survey when participants had to examine and decide about several statements without taking the context into account, overlooked the importance of context when making such a decision. This would be an explanation of the observed difference between the ESRM and web survey study.

Awareness was mostly needed during out of work hours when partners are apart. It surrounded mostly micro-coordination for dinner or for organizing children's activities. It was also surprising how pronounced is the need for information when one partner is at home and other family members are not. At home availability, schedule and location information is highest on participant preferences.

During working hours, awareness information needs are quite stable pertaining to availability for direct communication. Moreover, we noted a "shift of needs" during a working day. It seems that during mornings and afternoons the most prominent need is that of availability whereas in the evening it is that of coordination. Evening activities include preparing and having dinner so the information to coordinate for that is important. This finding again corroborates the interview study where it was found that since dinner is an important family activity information to plan and organize that is needed.

These two conclusions support the evidence found mainly in the interview study in Chapter 2 and decline the evidence found in the web survey study in Chapter 2 which were contradicting to the interview conclusions. Nevertheless the statement: *"that I am wishing him/her a good day"* was occasionally selected during the experience sampling so one cannot exclude that the need for affective communication might arise at specific contexts and times. This need however has markedly lesser priority and it supports the conclusions of the interview study in Chapter 2.

The argument in the previous paragraph would suggest that the web survey study in Chapter 2 produced contradicting however inaccurate evidence. Nevertheless, the finding supported in the web survey study that parents do want to automatically share information is corroborated in this study. This supports the added value of conducting the web survey study since it provided clear evidence that there is a role for awareness systems in supporting the communication needs of busy parents.

This chapter concludes the requirements elicitation studies which aimed to clear out contradicting evidence found by the studies in Chapter 2. Those requirements are utilized in the next chapter to build an awareness system designed for supporting the unmet communication needs of busy parents. Further, the system which is called FamilyAware is evaluated to appraise whether and in what way it satisfies those unmet communication needs.

# CHAPTER 5: EVALUATION OF A PERVASIVE AWARENESS SYSTEM DESIGNED FOR BUSY PARENTS

"The only way to engineer the future tomorrow is to have lived in it yesterday", Bill Buxton

# 5.1 INTRODUCTION

Having extensively researched, in previous chapters, the awareness needs of busy parents and what do they mean in terms of requirements for awareness systems, the following step to be taken would be to actually realize a working system based on the findings and evaluate whether and to what extent it would gratify the identified needs. In this chapter<sup>8</sup> we report the development and evaluation of FamilyAware, an awareness system designed for the communication needs of busy parents. The chapter begins by reviewing related work and findings which are important to raising requirements for awareness systems such as FamilyAware. Further on, FamilyAware's design and functionality is described. The evaluation of the system, the data analysis and the conclusions which can be drawn, are finally presented in the remaining sections of this chapter.

# 5.2 RELATED WORK

Most often research into systems to support awareness between family members has considered the case of distributed families or closely related individuals living far apart. This line of research has built up a body of empirical evidence to show that awareness systems promise to help family members feel connected (Markopoulos et al., 2004, Metaxas et al., 2007), feel safe or respectively reassured (Brown et al., 2007, Consolvo et al., 2004, Metaxas et al., 2007, Mynatt et al., 2001), and to be more involved in each other's life (Liecthi and Ichicawa, 2000, Markopoulos et al., 2004).

In their thorough investigation of everyday problems that working parents face, Sellen et al. (2004) identified several mundane challenges these people face daily, that communication technology can help them cope with: planning meals, planning and remembering activities for all family members, adapting plans during the day, etc. In that study, Sellen et al did not specifically aim to uncover the communication needs that this group has and did not answer the question whether increased awareness of each other's whereabouts and activities can provide added value to them.

There are still too few attempts to examine how individuals cohabiting could be supported (Brown et al., 2007); a clear challenge in this case is that users live together and already have a high degree of awareness of each other's rhythms of daily life, their whereabouts and needs. It is therefore harder for technology to provide an added value – indeed an important question we set out to explore is whether enhancing the awareness of each other is at all desirable, and if so, what aspects of each other's daily life are useful to communicate and for what purpose.

The ASTRA system (Markopoulos et al., 2004) supported awareness through messaging from a mobile family member to a homebound device shared within the household. Facilitating the creation and

<sup>&</sup>lt;sup>8</sup> Chapter 5 is based on the journal article: Evaluation of a pervasive awareness system designed for busy parents, 2009, Pervasive and mobile computing, Elsevier (Special Issue Human Behaviour in Ubiquitous Environments- to appear)

sending of very brief messages and pictures, and facilitating browsing and retrieval at home, were instrumental in lowering the threshold for communication. The system encouraged the capture and sharing of mundane experiences that could become a topic for communication later. Also it encouraged playful exchange of messages and the expression of affection for each other. An evaluation of ASTRA in a field test, lasting two weeks, provided both qualitative and quantitative data suggesting that it could provide affective benefits (such as higher connectedness, feelings of group attraction) without incurring costs (such as unmet expectations, feelings of privacy being compromised, etc.). However, ASTRA relied on 'manual' capture of information; this was designed to let users capture impressions and experiences at moments when they are clearly not in a rush and for purposes that were clearly not intended to be functional. This use is not as valuable for all families. In Chapter 2 we found that busy parents have much more functional needs for awareness; whereas ASTRA might have been suitable for sharing experiences especially during idle moments, it could not by itself provide added value to a phone call for the purposes of coordination and reassurance that were found by the aforementioned researchers to be important to busy parents.

The Whereabouts Clock (WAC) is a research prototype that provided location awareness for family members (Brown et al., 2007). This prototype underwent an extensive field trial with 26 participants that used it for several weeks (between four to nine). While it provides only coarse information (one of four possible readings are provided for location: home, work, school or elsewhere) families experienced rich affective benefits and embedded its use in their daily lives and rituals. The study did not compare use to non-use, and the impact of the research context on the behavior of the participants cannot be excluded. The benefits that WAC offers may be harder to sustain in a more dynamic context, e.g., when both parents work and commute, when they have to micro-coordinate for taking children to school, preparing dinner, etc. Related awareness needs were identified in Chapter 2; they require, among others, more flexible location descriptions, the information to be accessible in mobile contexts and even richer and more expressive means of communication. It is also important to note that participants in the evaluation of WAC felt that the system did not provide them with information that they already did not share with each other ("As they explained, the Clock displayed information that they already shared."). An implication of that fact was that WAC was not perceived as privacy intrusive.

Oulasvirta et al. (2007) in a study of a mobile awareness system were interested in the investigation of how users interpret mobile awareness cues as a situation, action, or intention of a remote person and how they subsequently act on them in social interactions. Their research included two field trials utilizing A–B intervention research methodology and one utilizing A-B-A. These studies were conducted over 243 days with 15 teenagers who were categorized in three groups. Each trial evaluated a slightly different variation of a contact list enhanced with awareness cues, e.g., describing availability of contacts listed, whether their phone is on or not, whether the phone is muted, number of people in the vicinity, etc. Although their study has been scientifically rigorous comparing use to non-use, participants in this research were teenagers and that fact makes their study results different from the focus we have.

Bentley and Metcalf (2007) reported a two week long field trial of three couples ("significant others") and a group of four friends of a mobile phone application through which users would be able to view the motion status of other people ("moving" or "not moving"). The authors did not specify whether the participating couples had children. In the case of couples that was the motion status of their partner. Through the application they were also able to send messages to each other as well directly call another user. A noteworthy finding is that users reported that the application did not add much to what they already knew: "In fact, our participants felt that they could infer a lot without the help of motion presence and that it mostly served to confirm what they already thought others were doing.". The same feeling was reported in the evaluation study of the WAC mentioned above. So while in both these studies participants seemed to be able to infer much more than the information the system provided them with (as the authors extensively report), we should not overlook the fact that they reported a feeling that these prototypes did not really add much. A question which emerges regarding the relevance and usefulness of awareness systems for intra-family communication is the extent to which awareness provides any added value to them.

In Chapter 2 we reported the triangulation of different research methods including in-depth interviews with 20 participants, a two-week long field trial of an awareness system connecting five "busy" parents with their children and a survey of 69 participants conducted over the web and showed that: (a) Some busy parents wish to exchange awareness information (automatically) during the day while others do not. (b) Availability of partner for coordinating family activities, daily activities in new family situations, activity, and location information of dependent children are salient awareness information needs for this group. (c) Awareness information needs are sensitive to context, suggesting the need for flexible mechanisms to manage the sharing of such information.

In Chapter 4 we presented an experience sampling study to find out what awareness information working parents would be willing to automatically exchange between them during a typical working week of theirs. This study left participants free to decide what kind of information should be shared at any moment, without making specific the nature of the system that would enable this sharing. Looking at the findings of this study, the need for affective communication between working parents while they were apart was found to be quite low. Rather, it was the need to share practical information that was their highest concern. Awareness was mostly needed during out of work hours when partners are apart. It concerned a lot micro-coordination for dinner or for organizing children's activities. During working hours, awareness information needs were quite stable pertaining to availability for direct communication ("Can I call now?). Moreover, awareness needs appear to follow some temporal pattern (relating of course to common daily routines for our target group). During mornings and afternoons the most prominent need was found to be that of availability whereas in the evening it was that of coordination. It was also surprising how pronounced was the need for information when one partner is at home and other family members are not. At home availability, schedule and location information was highest on participant preferences.

Considering busy parents as a specific target user group, evidence of the usefulness and applicability of awareness systems is still preliminary. There are still several questions left open for researchers and designers of such systems. We identify those in the section that follows.

# 5.3 RESEARCH QUESTIONS LEFT UNANSWERED

The special relationship of working parents makes the research of awareness systems even more interesting for two reasons. First given that these people have a lot of implicit knowledge about the activities and whereabouts of each other, would they find an added value in such systems? Moreover, in case that they would find value in such systems, which parts of these systems make them attractive and for what reasons?

Going beyond these general questions, we observed from the previous section that the reasons that working parents might use such systems are: availability, coordination, reassurance, capture and communicate nice moments and probably affection. Such needs are currently not met by existing systems. However existing literature has left unanswered some salient questions. The ones we identify and try to address in this Chapter are:

RQ1: Can we provide strong evidence regarding the relevance and adequacy of such systems for their users? The review of related research in the previous section shows that the methods used to yield that evidence has been mainly qualitative. Going beyond qualitative evidence can we provide any quantitative evidence that such systems do really add value? Moreover, to ensure that benefits reported follow from the use of the system it is important to compare use to non-use; this has been done in Oulasvirta et al. (2007). However, that study did not target working couples.

RQ2: Providing richer awareness information from different source has been implied to bring even greater added value to the use of awareness systems. The use of multiple awareness sources is still left unexplored. Thus the question which arises is: are there (even greater) benefits in providing awareness information from multiple sources? More specifically we observed that limited awareness information yielded a feeling of "not adding much" to what is already known or inferred. It rather confirmed what was already known. Are multiple sources of awareness information then the answer to that issue?

RQ3: An open question which is as important as the previous is how working parents would use an awareness system of multiple sources to add value to their communication needs and what would that imply for the design of such systems.

To address these research questions we set out to design, implement an awareness system and evaluate its actual use. An application was developed in accordance with the requirements identified in the studies presented in Chapters 2 and 4; namely to provide reassurance, coordination, affective communication and sharing nice moments. In the following two sections we describe the application we designed and the field trial conducted to evaluate it.

# **5.4 FAMILYAWARE**

There were three drivers in choosing for the functionality and the design of the system: our previous research results, feasibility and already known practices.

In the previous chapter we concluded into four unmet communication needs for busy parents. Those needs require to be translated to services that the system should have. However, a mere translation of needs to services is not sufficient due to restrictions of technology and resources. Therefore, after thinking what information would be required to link the communication needs to services and carefully calculating the feasibility of ideas, we ended up in deciding to develop five services: place, messages, activity, schedule and photo. In Figure 16 we try to capture our expectation of the link of the awareness information provided by the five services to the communication needs. For example, we expected that place information would be used to help users coordinate and also help them feel reassured about their activities unfolding during the day. Moreover, we expected that messages can help in both of the aforementioned needs and also help in communicating affection. Having in mind the need of determining availability of a person we expected activity and schedule information to help for that cause. Finally we expected that photos would be used to convey affection and to help users share their experiences during the day.



Figure 16: Link of awareness services of FamilyAware to communication needs of busy parents

The FamilyAware system combines five ways of communicating awareness information that are a mix of automatically constructed awareness information and information created and exchanged with input provided for this purpose by participants. We shall call these *implicit* and *explicit* input below in accordance to (Abowd and Mynatt, 2000). This mix combines the advantages of both: *Implicit input* offers the advantages of low effort and reduces costs of interruption (cognitive or social) for the user who is interested to know information about a connected other. *Explicit input* allows users to control their self-presentation, address privacy concerns, but also support expressiveness and self presentation.

FamilyAware was implemented as a combination of five awareness services running on top of the Amelie platform (Figure 17) (Metaxas et al., 2009). Amelie is an end user programming platform for designing awareness application based on the Focus-Nimbus model (Metaxas et al., 2008). Two of these services were developed on desktop PCs running Microsoft Windows and the rest on HTC mobile devices running Windows Mobile. The five services and the interface through which they are accessed are discussed below.





# 5.4.1 SHARING PLACE INFORMATION: LOCATIONLOCATOR

Place information is constructed from a combination of implicit and explicit input. Place descriptions are qualitative (not geographical coordinates) and personalized: the user can tag a particular place with a name that is personally meaningful, e.g., "office", "joe's", "canteen", "lunch", "jogging", etc., referring to locations, activities or combinations thereof that are associated with the specific location. Whenever in future occasions the user is at this location this name will be assumed by the system to describe this user's place. The user can override the automatically identified place. This may be useful when place identification turns out to be inaccurate or when a user wishes to determine what place is announced to others.

This approach provides two privacy safeguards: firstly users can name only those places where they wish, or do not mind, to be announced and secondly that they can still override this information with a plausible place description. Overriding implicit input of place may be done to conceal it, or to correct or refine a place description in order to serve the user's intentions relating to a range of 108
concerns that one's place information may influence, e.g., coordination, social interactions, privacy and self-presentation, etc.

Place tracking is supported by the LocationLocator application (Figure 18). This scans WiFi access points in the area of the user and compares them to those that are stored locally in the mobile device of the user in relation to a specific tag.

🎥 LocationLocate 📰 🎢 ┥ 10:45 🗙	🎥 LocationLocate 📰 🎢 📢 10:45
Name this place as: home ok	Name this place as: home ok
when checked my place is:	Ok, place named Successfully!
123 q w e r t y u i o p $\blacklozenge$ Tab a s d f g h j k l @   Shift z x c v b n m + * +   Ctl áü j / , , - <	Ontions
Options 🔤 📥	Options 🔤

Figure 18: By LocationLocator a user can name places he visits during a day. Those places are then automatically detected during the day. In the displayed screenshot a user taps the place 'home' and saves this place by tapping on the 'ok' button. The user receives immediately feedback of the successful action.

The LocationLocator service runs in the background; it wakes up the WiFi adapter every two minutes and scans for WiFi access points in the vicinity. The algorithm works as follows:

If in a previously stored place A we have recorded N1 number of access points and if N2 is the number of access points of N1 which were not found in the surrounding access points at the query moment, the probability of the user being at A is:

$$p = \log \frac{(N_1 - N_2) * 10}{N_1}, for \frac{(N_1 - N_2) * 10}{N_1} > 1 \land N_1 > 0$$

At any moment invoking the LocationLocator returns the place identifier with the highest probability as calculated with this formula; if no known access points are found the place is identified as *unknown*. Users can manage the list of known places by adding and deleting places. Places that are not static which cannot be associated with a fixed set of access points can be named using the manual option (see Figure 19), e.g., "train". Manually entered places are timed out after 20' to avoid the situation where users can leave it permanently in the wrong place. The same principle can be applied to different types of network protocols. A positioning system relying on the same principle but using multiple networks (e.g., Bluetooth, GSM) can enhance coverage and reliability; such an extension is left for future work.

The advantage of relying on WiFi access points for identifying place is that the positioning provides a relatively high accuracy and works especially well inside buildings. It can distinguish between one floor of the same building and another and can easily distinguish between places 30 meters apart provided there is a sufficiently dense installation of access points. Moreover, the resolution is variable but in a way that can be relevant to the movement of people: when in the open, a distance of 200 meters may be non consequential. When inside an office building where one works, smaller distances that are meaningful can be detected. Clearly many other technologies for positioning could be used to replace this one, or in combination with the one presented. The specific implementation worked satisfactorily for a short duration; one would need to make some refinements for long term usage to allow for a changing configuration of access points in any physical environment, for users deciding to edit the list of place identifications or even to share them with each other.

From a user perspective of course the underlying technology is transparent; what matters is the accuracy and coverage of the place identification. The formula above is a heuristic which we refined after several trials. Extensive work in combining different positioning technologies has already been conducted (Anderson and Muller, 2006). However, for the purposes of our application there was no off-the-shelve technology that we could readily apply and integrate in our application. For this reason, we implemented our own positioning solution to meet the requirements of our application context. Furthermore, we checked its reliability by performing several tasks during a pilot period in the whereabouts of the city where we recruited our participants and it was satisfactory for the purposes of our research. From this pilot test we concluded that this service was accurate enough for the purposes of our study.

🎥 LocationLocate 📰 🎢 📢 10:46 🗙	훩 LocationLocate 📰 🏹 🕼 16:36		
Name this place as:	Name this place as:		
when checked my place is: 01-12 10:46:26 Place: home (confidence: 0,85)	✓ whe After 20 minutes the checkbox will be unchecked.   Train unchecked.   Place: unknown		
Options 🔛	Options (12)		

Figure 19: The place with the highest probability is chosen, when checkbox is checked, nonstatic places (e.g. train) that could not be detected can be named for 20 minutes.

# 5.4.2 SHARING CALENDAR INFORMATION: FA CALENDAR

Calendar information is extracted automatically from a user's agenda. This was implemented as an application that queries MS Outlook about: the number of emails received, sent, deleted and the number of unread mails as well as the time when the last email was received. From the calendar it receives the total number of appointments for the day, the start and end time of the next appointment as well as the title and end time for the current appointment.



Figure 20: FA Calendar is installed on the desktop of participants and retrieves email and calendar information from Microsoft Outlook. For the purposes of our study we communicated the appointments of participants to each other.

At any moment the user can view the information that the application is collecting and exposing to his/her partner (Figure 20) by selecting the corresponding icon from the task bar. By right clicking the FamilyAware icon the user could exit the application and therefore stop the exposure of email and calendar awareness information. A similar approach for detecting and communicating presence and availability information for the office environment has been implemented in Microsoft Communicator.

#### 5.4.3 SHARING MESSAGES: FA MESSAGES

Users can also send messages using FamilyAware. This allows for flexible and brief communication and expressiveness. Any messaging service could address this need. Here we developed an application for Windows Mobile, its interface is shown in Figure 21. In the earlier studies it was found how approximate intended time of arrival at home is a salient piece of information busy parents wish to share very often. Special controls were added (see Figure 21) for easily indicating intended arrival time. The time last entered acts as a default thus facilitating easier entry when users have a regular schedule. Tying up place information could in the future make such a service adaptable.

🎥 FA Messages 🛛 🗱 🏹 📢 18:58 🗙	🐉 FA Messages 🛛 🗱 🏹 📢 18:58 🗙
FA messages	FA messages
Quick Message:	Quick Message:
Planning to be at home at:	Planning to be at home at:
Reset every day the time I plan to be	Reset every day the time I plan to be
123 q w e r t y u i o p 🔶	at home
Tabasd fghjkl@	EXPOSE
Shift z x c v b n m + * +	
Ctl áü ] / <	

Figure 21: User interface of FA Messages. With FA Messages participants could exchange messages and their intended time of being at home, through the mobile phone.

# 5.4.4 SHARING PHOTOGRAPHS: FA PHOTO

In line with the approach of ASTRA, a photo sharing application was implemented using the FA Photo service. FA Photo is a Windows Mobile based application through which the user can expose a photo captured on his mobile phone device (Figure 22). When tapping on the "Select From File" button the user sees thumbnails of the stored photos. The user can scroll through the photos and after choosing one the user sees a larger version of the photo in the interface. After tapping on the "Expose" button the original size of the photo is shared with the family members.



Figure 22: Selection and exposure of photos through FA Photo. With FA Photo participants could exchange photos they took during the day.

# 5.4.5 SHARING COMPUTER ACTIVITY: DESKTOP ACTIVITY

Finally we treat the desktop of the user as a rich source of awareness information that can portray pretty refined information about this person's current activity. We implemented a "desktop activity service" which abstracts away from the content of the screen signaling only mouse movement, keyboard activity, foreground applications, the detected location using a Geo-IP web-service as well as a "desktop silhouette" (Figure 23). The "desktop silhouette" is a desktop screenshot which removes any content information of the desktop applications and displays only an abstraction of the main lines of the desktop applications. This collection is of course indicative of what can easily be extracted from the desktop and how it can be conveyed without excessive detail that could threaten privacy. The desktop activity service can be stopped by the user of the desktop machine and is customizable, e.g., the user can specify the number of seconds after the last time that the mouse was moved, after which the mouse would be considered as inactive. The same option is given for the keyboard. The mouse and keyboard activity were used to communicate whether the user is "working on the computer".

Desktop Activity Service	SetupDig	
Desktop Activity Service Mouse is moving for 21 seconds Keyboard is idle for 21 seconds Active program: Iscapture, for 14 seconds Detected Location: Netherlands:Noord-Brabant,Eindhoven Last extracted desktop silhouette	Setupping   dtActivity service   Mouse and Keyboard Consider that my mouse is idle after   Consider that my keyboard is idle after 12 seconds of inactivity   Consider that my keyboard is idle after 20 seconds of inactivity   Consider that a program Consider that a program is active after seconds of use   Is Location Is Location Is Location   If wy mouse or keyboard were active during the last [4 minutes minutes	
Last profile update: 1 second ago Automatically start d/Activity when logon to this computer Uptions Quit	Desktop silhouette Take a snapshot of my desktop's silhouette every 20 seconds Ok Cancel	

Figure 23: Interface of Desktop activity and its settings. Desktop activity captures a screenshot of the desktop of participants (desktop silhouette) as well as whether participants are using the keyboard or mouse. In that way computer activity is communicated to the partner.

# 5.4.6 FAMILYAWARE MOBILE RENDERER

The FamilyAware interface was implemented as a renderer on the Amelie platform, which means that it is a service that renders all information the user has decided to expose. The service was developed to be presented as a background image on the user's mobile device; it uses the Today Plug-in of Windows Mobile devices to render HTML and present all the information exposed from a particular user to the one carrying the device. The application presents the awareness information received in blocks. Each block presents one item of awareness information (allowing for more or less to be displayed depending on how much the user exposes). In the second screenshot of Figure 24 one can see four blocks of awareness information: two messages, a photo and activity information. In the last screenshot a message is coupled with the place information. Next to the title the user can view the day and time of the exposed information. When clicking on the thumbnail of the photo the user can view a maximized version of the photo.



Figure 24: Screenshots of awareness information viewed on the mobile phone. The screenshot on the left exposes two messages and a photo. The next one exposes two messages, a photo and the activity of the participant. The next one depicts the exposed photo in larger scale. The last screenshot exposes a message and place information.

By tapping on the blue "i" icon shown in the middle of the first bar users can inspect the information they expose to their partner (Figure 25). By tapping on the "5 flags turned on", the user will view a page with five checkboxes. If the user wants to stop exposing a type of awareness information (s)he can do that by unchecking that type from the "Flagbox service". There is a final functionality on the main screen which lies behind the "settings" icon. When tapped, a user can choose the person and the awareness information he likes to focus on (Figure 25).

🔧 Start 🛛 🗱 🏹 🕂 🐼		🚰 Start	다 전 4× 6위 루		孷 Internet Explorer 🛛 🗱 🏝 🔺 🗙
Flagbox not initialized! 7:02:05 PM	-	Flagbox serv	ice 🗅	•	🔐 http://services.xrcnet.com:1080 🔻 🍖
Today plugin for smartphones					
Acquire from Javed 🔹		expose my pho	to		Information exposed to Miriam
the following information(legend)		expose my place	-		message (Wed 13:52)
✓ message <sup>1</sup> ✓ photo <sup>1</sup>					succes Thomas !
✓ activity <sup>1</sup> □ nimbus <sup>1</sup>		expose my mes	sages	•	marchen (Illed 12:52)
	_	expose my com	puter activity		plan to be at home at :
keyboard <sup>2</sup> location <sup>3</sup>		expose my cale	ndar		
status <sup>3</sup> availability <sup>3</sup>					place (today U7:26)
$\square$ mood <sup>3</sup> $\checkmark$ place <sup>3</sup>					
and display it on my smartphone's		save cancel			
today screen			Increased a		
save cancel	-			·	
Agenda Contacter		Calendar	Contacts		Favorites 12 Menu

Figure 25: Screenshots of the functionality behind the settings icon, the flags link and the blue i icon. The first screenshot depicts the screen from which the user can set the information he wants to acquire from his partner (for our study we had already set the information for participants). With the Flagbox service participants could stop sharing information with their partner. The last screenshot depicts the screen from which participants could view the information they were exposing to their partner and be self-aware of what is being shared.

# 5.4.7 DISCUSSION

The presentation of FamilyAware in this section has outlined the various awareness cues it presents and how they were implemented. The application itself is quite extensible as it relies on a service oriented architecture that allows new awareness information services to be easily integrated into the current application. The interface design was rather simple, a) following conventions for handheld application designs and b) supporting a variable set of awareness cues to populate each user's screen. In comparison with earlier systems that have been studied in the context of intra family awareness, FamilyAware innovates in giving the ability to participants to name and share places they visit during the day. There are already numerous location sharing applications (Google Latitude, Yahoo Fire Eagle, Loc8tion.com, Loopt.com, FindMe, etc.). These however rely on identifying and communicating absolute geographical position. An earlier system that offered qualitative positioning is the WAC device (Brown et al., 2007) which allowed participants to name and share with each other a closed set of places (home, work, school). With FamilyAware we took this concept a step further and opened it to users to name any place and not just a closed set of places. Furthermore, although the ContextContacts (Oulasvirta et al., 2007) have already tried a mobile awareness system with a plethora of awareness cues gathered from the mobile device, FamilyAware innovates in combining awareness information gathered from both mobile phones and the desktop.

Earlier systems have experimented with the use of explicit input of awareness information for the purposes of intra-family awareness. Examples are Hermes@Home (Saslis et al., 2006) which evaluated the exchange of written messages and ASTRA (Markopoulos et al., 2004) which involved the exchange of photos and short notes between mobile family members and family members while being at home, FamilyAware combines both explicit and implicit input of awareness information; more specifically the choice of information to be communicated is tailored to the communication needs of busy parents.

One can dream up a range of variants of this application comprising of different sets of awareness cues, perhaps supported by different technologies. One can expect future offerings in the field to bring about improvements of the underlying technology, the range of cues offered or even the visualizations presenting such information. Nevertheless, FamilyAware can be considered representative of the class of technologies we consider as they address the specific needs of busy families. This system offers a frequency and automation in information sharing that exceeds messaging and phone systems and the cues selected correspond to information that was found the most important to share by our target user group (as was reported in Chapter 2). In the following section we present the evaluation of FamilyAware and discuss how our findings reflect on the generic class of systems discussed in this chapter.

# 5.5 MOTIVATION FOR THE CHOICE OF SERVICES

Going beyond the requirements identified in the earlier studies described in Chapters 2 and 4, we would like to present additional evidence from other studies which influenced the choice of services.

# 5.5.1 MIXING EXPLICIT AND IMPLICIT AWARENESS INFORMATION

We wanted to have a mix of automatic, implicit awareness information captured by the activities of participants and manual, explicit awareness information which would be created by participants themselves. We wanted to include explicit awareness information such as messages and photos for two reasons. The prime reason was to give a channel for participants to communicate affection. We do not believe that affection can be automatically captured and communicated. Some kind of explicit

user action such as capturing a photo and exposing it to the user's spouse denotes interest. Effortless communication would not ideally communicate affection. The mix of explicit and implicit awareness information was found to be useful in an early testing of the Whereabouts Clock, a system communicating the location of family members (Sellen et al., 2006). More specifically, the researchers found out the need of exchanging messages along with place information. Therefore the mix of explicit and implicit has been shown to be required, however not to the extent of involving several awareness sources.

## 5.5.2 THE NEED OF SHARING PLACE INFORMATION

Existing literature has shown that sharing of place information helps users infer the availability of the person who is sharing that information. Moreover, it has been shown that sharing place information supports people coordinate activities, especially for micro-coordination. However systems such the WAC had a predefined set of places that users could set. In the evaluation of WAC it was also implied that enabling users to name their own place might be even more beneficial. PlaceMail (Ludford et al., 2007), a system which enables users to create personal reminder messages and deliver them at userspecified places on their mobile phone, had left open to participants to name places they visit. However, this system investigated the user preferences in sharing place names with any other user of this system. Participants were not keen in sharing their home location, the location of other people's homes or their workplace unless it was a public venue. Thus, here there is a clear difference in sharing place information between users who have a strong relationship, such as couples and sharing place information with other people. In the case of couples knowing when somebody has arrived home is crucial for coordination and reassurance; whereas in the case of sharing that information to the public is seen as a security threat. Moreover, Reno (Smith et al., 2005), a system designed to share place information between users, had also left it up to participants to name places they wanted to share. However the place information was actively pushed or pulled by users and automatically shared only in predefined places. A pilot evaluation of Reno showed that the spousal relationship had the highest amount of location disclosures (45% of all requests for location; 21 total requests). The findings of Reno reinforced our decision for providing an open-ended place naming and sharing service for busy parents.

#### 5.5.3 THE NEED OF CALENDAR INFORMATION

Neustaedter et al. (2009) in their extensive investigation of families' calendar use, have shown how important is the information kept in calendars for family coordination. Since coordination and availability was identified in the literature as a need families have, calendar information seems an obvious resource of awareness information to share between parents. With the feasibility in mind, we tried to encapsulate as many functions as possible to have a system which would be as generic as possible. The difficulty in having an ideal pervasive awareness system lays in the integration of useful awareness information captured by a plethora of systems. A perfect example of this problem is schedule information. There are several calendar systems that people use to schedule their meetings and appointments (MS Outlook, Google Calendar, Yahoo online services, MSN Calendar, etc.). It is also in many cases that a single user will use several ones. A pervasive awareness system that wants to

capture and communicate useful schedule information would need to integrate all those systems. That would mean having authentication and data retrieval functions for each system. Although that is not an impossible task however it is extremely difficult considering the time and resources we had. Therefore for the specific service we decided to focus on MS Outlook since we knew it was the most used calendar system for the businesses and organizations in the area of Eindhoven.

# 5.5.4 ACTIVITY INFORMATION

Desktop activity was chosen as the easiest information that we could tap into the activities of a remote parent. Bentley and Metcalf's (2007) motion sharing system demonstrated that from sharing whether one was moving or not, participants were able to infer the activity of the remote user. Moreover, activity was useful to infer availability and coordinate (Bentley and Metcalf, 2007). Therefore, it seems that activity information is useful when it comes to inferring availability and to help people coordinate. Since the use of the computer is pervasive to many professions we thought that tapping into the computer activity of a busy parent and sharing this information with the other parent, would support them in inferring their availability and help them to coordinate mundane, daily family activities. Furthermore, although other systems such as ContextContacts (Oulasvirta et al., 2005) have already tried a mobile awareness system with a plethora of awareness cues gathered from the mobile device, FamilyAware innovates in combining awareness information gathered from both mobile phones and the desktop. Another argument for including both desktop and calendar activity, a large part of which one would expect to be related to workplace awareness, was based on the study of Neustaedter et al. (2009). In that study the researchers claim that for families "coordination routines are intermixed amidst everyday life and extend beyond the home to include scheduling while at work or mobile". Under the light of this claim it only makes sense that any sources of workplace awareness would benefit the communication needs of busy parents.

# 5.5.5 SHARING PHOTOS

The ASTRA system had shown the need people had in sharing simple, everyday happenings with other family members and friends. Although ASTRA did not specifically target busy parents, there is some evidence from the web survey study presented in Chapter 2, that sharing nice moments during a day is something that busy parents do find interesting. We thought that sharing photos would be useful to experiment with to corroborate whether parents did actually find it a useful feature.

# **5.6 EVALUATION OF FAMILYAWARE**

The evaluation attempted to establish whether FamilyAware provides added value as a communication medium to busy parents, when considered in the context of their daily life and their current use of communication media. Following the motivation for this design outlined above, our working hypothesis therefore was that our system would be used to satisfy the needs of *availability, coordination, reassurance* and *affection*.

Evaluation of the affective experience of using this technology is challenging. Experiences vary over time, are context dependent, can be difficult to recall and place in context after the fact. In short, the

evaluation poses a set of challenges that are typical for the evaluation of ubicomp technologies (Abowd and Mynatt, 2000, Carter et al., 2008, Markopoulos 2005).

We therefore decided to run a one month field trial, involving 20 busy parents. We combined the following data collection methods:

- Post-Questionnaire to assess how the four aforementioned needs are met
- Qualitative data using post-interviews to elucidate the results of the questionnaire
- System log data for understanding participants' usage of the system
- Diary entries to capture the context of use during the study period

An A-B-A study design was adopted to enable comparisons to be made between using the system (B) to non use (A). The A-B-A study design along with the application of the questionnaire was chosen to address RQ1. Recall that the purpose of RQ1 was to go beyond qualitative findings and collect quantitative evidence to examine the proclaimed by qualitative evidence communication benefits. To shed light on whether multiple sources of awareness information do actually add value (RQ2) again the questionnaire will help finding out whether the usage of this particular system has changed something to previous communication habits of busy parents. Moreover the debriefing interviews were chosen to discuss with participants their usage with the system and reveal the reasons the system was used. Diary entries were chosen for situating the use of the system in particular events that occurred during the two week usage which would otherwise be forgotten during the debriefing interviews. Moreover, the diary entries would create a basis at the debriefing interviews by grounding the discussion to reported events. Both the diary and interview methods were chosen to address RQ3. By discussing events that occurred with the system as well as the experience of participants we would be able to better understand which design choices of FamilyAware were successful and what was actually missing from the system itself.

ESM has been used in evaluating systems in the past (Consolvo and Walker, 2003) thus a question which could be raised is why ESM, or ESRM which was presented in Chapter 3, was not chosen as an evaluation method? The main reason for **not** choosing such a method was the amount of time needed to reengineer the tool features to use it for evaluation purposes. As highlighted in Chapter 3, a generic tool which could be easily tweaked by researchers to be applied in different research domains is not quite yet there. Redeveloping existing tools are costly in time and resources and that is the main disadvantage presented against the use of the ESM (Kahneman et al., 2004).

# 5.6.1 PARTICIPANTS

To recruit participants, we used a database of participants of our University<sup>9</sup>. Around twenty couples responded to our call however we chose ten couples which best fitted our requirements. The

<sup>&</sup>lt;sup>9</sup> The database includes members of the university stuff

requirements were that participants had to be married or cohabiting, were both working and had at least one dependent child. Participants were told beforehand that they would be paid with gift vouchers. We screened participants to ensure they were married or cohabiting, were both working at least part-time and had at least one dependent child.

The average age of participants was 36.75 years (sd: 6.62), the average years of partnership 14.25 (sd: 8.76) the average hours of work per week 32.35 (sd: 10.38) the average number of children 2.3 (sd: 1) and the average age of children was 9.46 years (sd: 5.19).

The average number of times per day our participants use their mobile phone to communicate with their partner are 1.32 (sd: 1.28), the fixed phone 0.67 (sd: 0.88), the email 0.67 (sd: 1.3) and the SMS 0.0035 (sd: 0.02). If we add up the averages this equals to an average of 2.66 mediated communication events per day. An interesting characteristic of this sample is that they use synchronous communication (mobile phone and fixed phone) more frequently than asynchronous. Another interesting observation is that the frequency of the exchange of instant messages is evidently low, virtually zero. Participants have a mix of different socio economic classes, professions and educational levels.

#### 5.6.2 MATERIALS

The materials included for the study were an HTC mobile phone with GPRS connection running FamilyAware, the two desktop applications for supporting the desktop activity and calendar awareness cues, and a web application through which questionnaires and diaries were administered.

To collect participants' data we developed a web application (Figure 26, Figure 27) for two purposes. First, to capture the required data in an easy way for participants and the researcher alike and, second to have a central reference point for participants in case they needed more information. Furthermore, it simplified tracking the development of the data collection.

Participants used this web application to read, accept and sign (digitally) the consent form, provide demographic data, schedule meetings and fill out questionnaires. Furthermore, through this application they had access to a short usage manual for the system we provided them, our contact information and a place to view announcements.



Figure 26: First tab of web application presents a short usage manual for the system

I-12-2008 /elcome, Mr.	Instructions Consent Form Demograp	hics Form Meetings Contact Checklist Questionnaire NEWS						
ogout	Name	Vassilis-Javed						
	Surname	Khan						
	Partner of	Mrs. Anna Hasan						
	Years of marriage/partnership	3						
	Occupation							
	Hours of work (per week)	3						
	Number of children	1						
	Ages of children	2 (comma separated)						
	Telephone number	402474019 (in case we need to contact you)						
	Address	Venuslaan 64 5632HA Eindhoven						
	I use the 📃 🚽 approximat	elly times per vto communicate with my partner Add						
	I use the phone (fixed) approximatelly 3 times per month to communicate with my partner $\cdot$							
	I use the mobile phone approximatelly 1 times per week to communicate with my partner							
	I use the MMS approximatelly 4 times per month to communicate with my partner							

Figure 27: At the third tab of the web application participants were asked to fill out demographic information

Despite our expectations not all participants could install the desktop applications supporting the activity awareness and calendar awareness cues. For most of them, their employer prohibited the installation of third party software, especially software that would record and communicate

information about their employee. For others, the calendar application was not useful/relevant as they do not use MS Outlook as their calendar program.

Eventually, just three participants installed the calendar application and nine participants installed the computer activity application. Out of those nine participants three installed the application in their home computer and the remaining six at their office computer. This already shows some of the obstacles one can expect of installing context capture technologies of this kind and second, that the implementation used for this evaluation could not provide the intended accuracy and richness of data envisaged during the design.

A difficulty regarding the nature of this study was that if there was a problem with one of the devices then both the participants' data would be unusable. For example, if one device had a problem with the GPRS connection then it would neither be able to send nor receive data and that would make the purpose of the other partner's device useless. Therefore we thoroughly piloted the application for a period of five weeks before the study. However, we will present in the following sections cases where two couples that still experienced technical problems with the system, illustrating some of the challenges of field testing as described in Consolvo et al. (2007).

#### 5.6.3 MEASURES

#### 5.6.3.1 SYSTEM LOG DATA

We logged the number and content of messages exposed to find out whether FamilyAware provided a more convenient way for parents to exchange messages and if that was the case what would those messages be. Then, we logged the number and the photos exposed through the system again to see whether the system provided a more effective way to expose photos and what kind of photos would then be interested in sharing. Furthermore, we logged the number and wording of places exposed to find out how many and in what detail would they name places to be exposed. Finally the timestamp of the information exposed was also logged. On the whole, we were interested in having this log to give us a better idea in what manner the system was used.

#### 5.6.3.2 QUESTIONNAIRE

A questionnaire was compiled to survey participants regarding the use of all communication media at their disposal for the last week in terms of availability awareness, coordination, reassurance and expressing affection (which correspond to the intended benefits of the system).

The questionnaire was filled out four times: just before receiving our system (week 1), after one week of using the system (week 2), after two weeks of using the system (week 3) and a week after the intervention (week 4).

Table 17: Questionnaire items participants were asked to rate before, during and after the system intervention

necu
reassurance
reassurance
availability
availability
coordination
coordination
coordination
affection
affection

The questionnaire items are shown in Table 17. The order of items was randomized each time the questionnaire was accessed. The "X" on the questionnaire items was replaced by the addressed partner's first name. We developed at least two items to address the needs of reassurance, availability, coordination and affection. Participants were asked to rate the items on the web application in a seven-point scale (Figure 28).

As part of the development of a social connectedness questionnaire we also asked another 24 questions relating to connectedness. These 24 were presented along with the nine aforementioned. The results for the social connectedness questionnaire will not be presented as we did not hypothesize any improvements in the feelings of connectedness between the participants as a result of using our system; since they already are very much connected and living together. The reason for placing these additional items was twofold. The first reason was to evaluate the internal validity of the questionnaire items and the second to avoid a memory bias for the nine items we were mainly interested in.

	Т	U/e Technische Universitei Eindhoven University of Technolo	ambient awareness	SenterNovem
Instructions	Consent Form	Demographics Form	Meetings Contact	Checklist Questionnaire NEWS
On this page medium (e.ç right or wron questions for a certain ans last week.	you will be ask J. phone, mobil g answers, we a long time, bu wer. Just try to	ed questions about you le phone, email) and l are interested in your p t try to rely on your firs give the answer that y	a experiences regardin NOT your face-to-fac personal opinions and e t reaction. It is no prol ou think is most suitab	g communication with Anna using a :e communication. There are no experiences. Do not think about blem if you are not sure about giving le. When answering think of your
1 = I strongly 2 = I disagre 3 = I disagre 4 = I agree n 5 = I agree 6 = I agree 7 = I strongly	/ disagree e a little ior disagree l little / agree			
1.This week	Anna knows v	when it is a good time	e to call me	
Strongly dis	agree 1 2 3 0 0 0	4 5 6 7 Strongly	y agree	
2.This week	I feel that Anr	na is reassured that t	he family's activities	go as planned
Strongly dis	agree 1 2 3 0 0 0	4 5 6 7 Strongly	y agree	
3.This week	l know when i	it is a good time to ca	II Anna	
Strongly dis	agree 1 2 3 0 0 0	4 5 6 7 Strongly	y agree	

Figure 28: View of the web application interface in which participants were asked to rate in a 7-point scale the statements regarding the communication needs we wanted to evaluate

#### 5.6.3.3 DIARIES

Qualitative data was gathered through diaries and interviews. With this data we aimed to find the reasons behind the behavior observed through the logs and the appraisals reported through the questionnaires. The diary was administered by email to facilitate respondents and also to act as a reminder to report punctually. Participants were asked per email twice weekly the following questions:

1. "Did you check at all the mobile system we provided you? If yes please quickly describe how. If no please describe why not.".

This question was posed during our system intervention (B).

2. "Tell us about a case where you wanted to use, or used either a phone or another communication system to reach your partner the last two days. Could you describe the time, place, activity and the reason you called?"

This question was posed before, during and after our system intervention (A-B-A).

#### 5.6.3.4 INTERVIEWS

The interviews lasted approximately 30 minutes and were conducted in person with the couple. We began with open-ended questions to let the participants voice their most striking experiences of the system. We then posed follow up questions to explore the following issues in more depth. We were

interested in the usage of the system and which functionality was used as well as the reasons for using it. We were also interested in the patterns of usage. How many times did participants look at the device? Where did they keep the device? Another point of interest was the inferences that they could make by having that awareness information as well as whether their communication had altered in any way during the period of these two weeks. Problems relating to both functionality and usability were covered.

We were also eager to find out whether there were more subtle "communication costs" of this system such as whether it raised expectations that could not be fulfilled, whether it interrupted participants from their daily activities or whether it compromised their privacy in any way. The interview guide for those costs was shaped with the help of reviewing the scales of the Affective Benefits and Costs of communication questionnaire (van Baren et al., 2003). Interviews were audio-recorded, transcribed and analyzed qualitatively using a directed content analysis (Hsieh and Shannon, 2005). Initially we had the categories: functionality, usability, experience, system usage and inferences in mind. We also had the categories: change of habits, inferences, system usage, design suggestions.

With the first three categories we wanted to record the pros and cons that participants found in terms of functionality, usability and their overall experience of the system. Furthermore, we wanted to see whether the system we introduced changed their communication habits in any way. Moreover, we particularly wanted to find out whether participants used the system to satisfy the aforementioned communication needs. Was the provided information actually useful for them to infer the availability of their partner? Was it useful to coordinate activities during the day? Did it provide some reassurance that activities were normally unfolding during the day? Was the system any useful in conveying affection? Thus, a main point of interest for us was the inferences they could make about each other. A couple already has a lot of implicit knowledge of each other. Did that change by providing awareness cues on the mobile phone? Moreover, during the interviews some participants provided suggestions to improve the system. These suggestions were useful insights into the way they experienced the system was used in any way that we did not expect or whether there had been situations in which the system could be used in ways unforeseen.

#### 5.6.4 PROCEDURE

The study was designed to last a month for each participating couple (Figure 29). Participating couples were recruited approximately three weeks before the study began. In the first week of the study the email diary began. Couples were called to report on their mediated communication. Moreover, demographic information was gathered. At the end of the first week participants were asked to fill out the questionnaire. This provided a baseline to compare the answers of the questionnaire after our system intervention.



Figure 29: Evaluation procedure. Participants were emailed thrice per week for filling out the diary questions and were asked to fill out the questionnaire four times during the month-long study (A: no interaction with FamilyAware system, B: usage of FamilyAware system)

Next, the mobile phones were handed to the participants. At that meeting both participants were present. An introduction to the system and the research was first given and then a list of training tasks was performed by the participants. With the completion of the tasks we wanted to make sure that participants were able to use the device as well as our system and its functions. For the next two weeks participants used the system and were emailed to record their communication events. At the end of each week they were asked to fill out the questionnaire. At the end of the second week the system was taken away. At that meeting participants were debriefed. They were also reminded that the study would last one more week in which we continued to email them to complete the diary. At the end of the month we asked participants to fill out the questionnaire for the last time.

#### 5.6.5 RESULTS

The experiment proceeded as planned with the exception of two couples who could not use the system because of limited GPRS coverage in their area (they live at the border of the country and different networks operate in each side of the border). Further, one of the participants was ill for a few days during the test making the use of the system unnecessary. The other couple experienced two problems: first a hardware malfunction and on another occasion using up all pre-paid credit as they crossed the border for a day and the tariff for communication costs increased unexpectedly. As these were the first couple taking part, it helped us introduce programmatic controls to avoid this problem for the remaining participants.

Only 15 out of the 20 participants completed the questionnaire all four times as requested and therefore these results reflect those 15 participants only. Thus, given the relatively small subject numbers the results presented in this section should be primarily understood as trends which need to be examined further.

#### 5.6.5.1 QUESTIONNAIRE ANALYSIS

We present the scores obtained from the questionnaire to compare week 1 (before intervention) to the scores obtained in week 3 (after two weeks of use) to see if the intervention had a beneficial

effect, and between week 4 and week 3 to see if the withdrawal of FamilyAware would produce the reverse effect. Moreover, we wanted to compare week 1 and week 3 because we expected the "wow-effect" of the new system to have been rebated at week 3. Comparisons with a 2-tailed Wilkoxon signed-ranks test are summarized in Table 18.

Table 18: Data analysis before the intervention to the end of the intervention

	Week 1 (before in	itervention)			Week 3 (after 2 w	eeks of use)			
- Week 3					- Week 4				
	(after 2 weeks of use) <b>p W N</b>					p W N			
Q1*	.03	6	10	Q1	>.10	-5	6		
(reassure	ed for family	's activities)							
Q2	>.10	13.5	9	Q2	>.10	-12	7		
(X is reas	sured for fa	mily's activitie	es)						
Q3**	.08	10.5	10	Q3**	.07	-10	10		
(when it	is a good tir	me to call X)							
Q4*	.005	1.5	11	Q4*	.01	-6	11		
(X know	s when it is a	a good time to	o call me)						
Q5	>.10	12	8	Q5*	.008	-7.5	13		
(I know v	when X is at	home)							
Q6*	.003	3.5	13	Q6**	.08	-2	7		
(coordin	ate tasks we	ell with X as I o	ome back fro	om work)					
Q7*	.002	0	12	Q7	>.10	-5	7		
(coordin	ate task wel	l with X as X c	omes back fr	om work)					
Q8**	.08	13.5	11	Q8	>.10	-6	7		
(l can ex	press my fee	elings to X)							
09*	.02	8	11	09	>.10	-6	7		

Questions 1 and 2 were intended to evaluate whether our system helped participants in feeling reassured about the family well being. A positive effect was found only for Q1 when comparing week 1 to week 3, and only when participants were reporting on the reassurance they experienced themselves. While encouraging this data does not allow us to assume that the system made any difference in helping participants to feel reassured about how family activities are evolving during the day.

Question 4 ("X knows when it is a good time to call me") resulted in significantly higher answers during the intervention weeks, compared to non use (both pre and post intervention): participants felt that their partner could evaluate their availability better using FamilyAware. However, this was not reflected as clearly (only a trend was found) regarding participants' own ability to evaluate their partner's availability.

Questions 5, 6 and 7 concerned the use of FamilyAware for coordination. Only question 6 showed a significant benefit and question 5 only showed a significant decrease upon its relation to the withdrawal of the system. While we cannot draw an unequivocal conclusion, there is positive indication that our system helped coordinate tasks busy parents need to perform during a typical day of theirs.



Figure 30: Mean scores of the four evaluated communication needs during the four weeks of the study. A distinctive increase in all four needs during weeks 2 and 3 (during the system intervention period) is observed.

There are two interesting remarks that hold for all measurements. Looking at the data over the 4 weeks that measurements were taken, we see for all cases that the introduction of the system had a positive effect, increasing from week 1 to week 2, the highest measurements were obtained in week 3 and a clear drop in the measures was found in week 4 (Figure 30). It would be interesting to see what longer exposure to the system would result in. Further, we note that all measures (including the week prior to the introduction of the system) are pretty high. This may have caused a ceiling effect on week 2, which may have disguised differences in the statistical analysis. The drop of the measures in the 4<sup>th</sup> week makes it clear that it is not the participation in the experiment that causes observed effects (so no 'Hawthorne effect'); though one cannot discount a possible social desirability bias. This claim can be made since in the 4<sup>th</sup> week participants were still under investigation they would (according to the Hawthorne effect) continue to exhibit the same rating behaviour. However, they did not. This fact means that it was the removal of the FamilyAware system which caused this drop and not the fact

that we were observing them. Such a bias however could not account for the increase observed between week 2 and week 3 (Figure 31). Another observation is that three out of the four questions score higher in week 4 than in week one (about coordination), but one does not. That would mean that for the one that did not score higher (coordination) this was an even more profound need. By removing the system the need became even more apparent to participants and the removal of the system caused actually (slight) difficulty to participants in coordinating their evening activities.



Figure 31: Mean scores of all questions during the four weeks of the study.

These observations evidently mean that our system has a potential in addressing all communication needs it was designed for. The data also suggests that it would be interesting to run the study for even longer to be able to discriminate effects of using the system from the effects resulting from the study itself.

#### 5.6.5.2 INTERVIEW AND DIARY DATA

In order to obtain explanations and elaborations of the effects found from the questionnaire data we examine the interview and diary data.

Participants reported some usability and functionality problems. For all but two participants, this was the first time that they had operated a smartphone; none was familiar with touch screen interaction on a handheld device or with soft keyboards. Although they had some familiarity with Windows on a PC, there were several aspects of Windows Mobile that were completely new to them.

In the words of participant 15: "It's more getting used to it, because this is two weeks and ... because when I get a new phone every year from my boss it takes me a couple of weeks to get used to the new device". We should stress that this was the only explicit comment we received about the short duration of usage and other participants did not explicitly complain about the study period being

very short. However we feel that this comment is indicative that for such studies allowances must be made for participants to become accustomed with the devices they are asked to use.

The novelty of the interaction styles supported caused difficulties in operating the soft keyboard, switching between the text completion (T9) function of the Dutch keyboard and the English one, the small size of fonts on the interface made reading difficult as well as being cumbersome to use the stylus to operate the system. However, participants seemed to overcome such problems rapidly.

Having to carry a second mobile device next to their own phone was not the optimal solution for participants, who mentioned that they would have made more use of the information provided by our device if it was embedded with the one that they already use. In the words of participant 9: "*if it was on my phone adding something, that would have been the best, now I had two devices*". In the words of participant 10: "*if it was on my mobile phone it was much easier*". That was because synchronous and asynchronous communication was now split for them. They were asynchronously receiving information about their partner in one device but could only call with their own device. In the words of a participant 15: "*if this would be our only device we would probably use all the extras (referring to the information provided by our system) cause now we mainly used it for pictures*". Consolvo et al. (2007) have extensively discussed the advantages and disadvantages of providing participants with a second device in their studies. Among the disadvantages mentioned are that participants might be less likely to carry the second device and that they would be using the application in the same frequency. In our study only one participant mentioned that he would sometimes forget the device we provided him with. However, it was most of the participants' opinion that they would use our applications more frequently when installed on their phones.

Furthermore, there were a few cases in which participants fell ill for a couple of days or had to make a short business trip in a neighboring country during the two weeks that they were asked to operate our system. In the latter case we instructed them to operate the device only while being in the Netherlands since all the available credit for GPRS use would be exhausted.

Additionally, six participants complained about the fact that the battery would be quickly drained. Our use of both the WiFi adapter and the GPRS adapter was draining the battery of some devices, forcing participants to charge the devices every evening. This was against their expectations since they were used in charging their mobile phones once per week. In the words of participant 10: *"The battery was very quickly empty, so that was a pity."* (from a diary excerpt). Participant 10 also reported it in a diary entry: *"It's only a pity that the battery from the device has a low capacity."*. This issue is also reported in other studies (Consolvo et al., 2007, Holmquist et al., 1999).

There were also few cases reported in which the device would get stuck. Then participants were instructed to reset the device. Moreover, two participants mentioned cases in which they wanted to name a place but could not do so because of the lack of WiFi access points in the area. In one case a

participant was working in a basement whereas in another there were obviously no WiFi access points nearby.

During the interviews participants downplayed the inconvenience caused by these problems, describing the system as "ok for two weeks". However, one can imagine that these problems must have impacted the experience of using the system negatively; in light of this, the positive results regarding the benefits that this application succeeded in delivering are perhaps more noteworthy.

#### 5.6.5.3 ON AVAILABILITY

Place information was consistently used by participants to determine the availability of the other partner. Furthermore, it is interesting that it was proactively used by participants to set specific places that would help their partner in determining their availability. An interesting finding comes from a couple who explicitly made the agreement that when the system would detect the place of the husband as his desk at the office then that meant that his wife could call him. In any other case he was not to be disturbed. In the words of this participant (participant 5): "Oh yes! It is my favorite part of it!" (replying to the question of her partner: "did you use the place information?"). She went further in explaining why: "If I knew that he was at the office I knew that now I cannot disturb him, I liked it cause you get a picture in your head, he is at his office, his desk"; this participant does not just describe a functional value of this information but also an emotional one. This finding would be similar to a chat program, when you can see if someone is at the computer. She liked the fact that she could have a better mental picture of her husband's whereabouts. When asked on how she would determine if it was a good time to call before using FamilyAware she says: "I would just pick up the phone and he might say: "I am in a meeting don't disturb me" and then you feel a little bit disappointed, you put down the phone and you try later or not". Furthermore, the husband also agreed that his wife could make a more informed choice when she wanted to call him. So, for this particular couple the system was indeed useful in helping them determine their availability. More couples found place information as a useful cue for inferring availability. Participant 8 recalls in a diary entry: "We shared some photos and I check whether my wife was available at home, so that I could contact her by alternative means".

In another case, participant 8 used the computer activity to send emails to his wife because he knew that she would respond quickly. In his own words: "Yes, sometimes I used it because then I could mail her (laughs) then I know she could respond immediately on my mail so that added to our communication". This participant said that he would first check the system and then decide whether to mail or not. His wife also found the computer activity cue useful for inferring his availability but in her case she would select a different medium. In her own words (from a diary excerpt): "I checked on the system if <participant 8> is on his computer working so I can call him.". Thus, this couple not only inferred availability from the computer activity cue but also informed their choice of appropriate communication medium.

In a case of another couple in which the husband occasionally had to travel for his work it was again the place information that helped his wife (participant 26) to determine his availability. In her own words: "I thought it was useful because I know if he was in a special place that I could not reach him by phone, so then I know he is there and in one hour I can reach him because now he is busy". Her husband used the LocationLocator to set the meeting place in a business trip he had during our evaluation period. His wife then determined that he is on his way back home when she stopped receiving as his place the meeting place and instead was receiving "unknown".

Furthermore, from a diary entry of participant 9 we read: "Saturday I first wanted to phone <his wife, participant 10> and then I decided to first look at the device if I could see where she was.". Thus in this case too, our system clearly was used to infer availability and changed the communication habit of this participant.

On the other hand, there were couples for whom determining each other's availability is not an issue. If they want to communicate they pick up the phone and place a call without attempting to establish if it is a good time to call. It seems that the type of work and the culture of the company play the most salient role in that. Additionally, the detail with which participants would name a place was important for the information to be useful in determining availability. In the case of participant 6, he mentions that he did not find place information useful because the places named by his wife had a broad meaning; i.e. "work", "home". This means that participants and generally users of such an application may need to build up some experience from use or receive advice before their choices of names become meaningful and informative (assuming of course, this is what they wish). In terms of positioning technology that is used to support the implementation this finding suggests that finer grain information than just geographical coordinates is necessary such as room level positioning inside buildings.

Clearly, the need to determine whether someone is available is not the same for all couples. However, from the evidence we gather by interviewing our participants it seems that our system helped in the cases in which determining the availability of the partner was important. The awareness cues used for that reason were mainly place and secondly computer activity.

#### 5.6.5.4 ON COORDINATION

Consistently with the earlier studies presented in Chapters 2 and 4, our participants had a pronounced need for communicating, updating and coordinating the time they would get back home from work. As we had expected a major motivation was to coordinate dinner with the whole family so participants made good use of all awareness cues provided to them to coordinate their return home from work. Participant 7, would combine information gathered from the computer activity and the predefined message ("Planning to be at home at: ...") to infer whether her husband would be on his way back to home. Her husband would set the message to a time that he predicted of being back home and she would check that message. However she would also cross check it with the computer activity to verify whether his prediction would be accurate. So if she would see that he was still working with his computer while the predicted time had already elapsed, she would know that he is going to be later than he had initially predicted. In this particular situation explicit

communications (i.e. the message) was crosschecked with automatically generated awareness cues to make a reliable inference.

However, this was not the case for other couples. For participants 5 and 6, the predefined message ("Planning to be at home at: ...") was useful and as they told us in the interview that it even replaced a ritual phone call. Usually, as the participants said, they would place a phone call to share their intended time of arrival back home. A similar phone call was also both reported and replaced also in the cases of three more couples. When these couples were asked whether they missed that phone call they all replied negatively. They liked the practical aspect of the message. In the words of participant 6: *"it was easier than giving a phone call"*. In another case, participants 12 and 13 combined explicitly written messages with the predefined message to infer the time of arrival. For example, when one of them would be traveling back by train she would write a message about it and her husband would combine the predefined message with the explicitly written message to determine her time of arrival.

Place information was also used to determine the time of arrival at home. In the words of participant 10: "Because he is always going by train to his work, I saw when he left his work at a particular hour so I did know: Ah! He is in the train and will be home at a certain time". Her husband also agreed that this particular information was useful and even that he wanted it to be shown to his wife. This particular use of information was reported by several other couples. In the words of participant 26: "I would first check to see whether he left office and then started preparing for dinner".

It is an interesting finding to note the participants' use of information for making broad inferences. It was actually the transition of place information from "work" or "office" to "unknown" which participants were trying to detect when seeking to infer the time of arrival at home. This tracking of transitions in particularly place information was reported by several couples. They mentioned during the interviews that having a history of places visited during the day would be useful. Thus, in the case of place information it is not just the place itself which is useful when trying to determine arrival at home but the transitions from one place to another.

To summarize, we found that in the case of coordinating tasks a mix of different awareness cues were used. We also noticed that a combination of automatically captured awareness information with manually inserted awareness information made a valuable resource. As a concluding remark, we found that it was actually transitions of places that were more useful than the place information itself. Longer term deployment of FamilyAware would be needed to corroborate such findings.

#### 5.6.5.5 ON REASSURANCE

Next we would like to present what was reported in the interviews on how participants used awareness cues to be reassured regarding the progress of daily routine. Surprisingly, it was actually a usability issue that participants had with our application which revealed an important differentiation in their communication. The most prominent usability issue, mentioned by all of the participants was the option for a notification on the arrival of new information as well as when the other party had read the information. Participants mentioned that they wanted to have the option of being notified when new information had arrived in their device because it might be important and because they did not want to keep on checking the device only to see that nothing had changed. Moreover, they were accustomed to their own mobile phone devices notifying them when there is a SMS or a phone call and they missed that in our system. When asked why they wanted to have such a notification participants mentioned that that it would be needed in case of information that is urgent. The reported example was when plans of picking up their child would change. Nevertheless, they also mentioned that this was not always the case and it was rather infrequent but salient.

So it seems that there are two tracks of communication between busy parents during a typical working day of theirs; one for reassurance and one for urgency. In cases of urgency they require the direct, synchronous and rich communication offered by the phone. Couples who used to make reassurance phone calls before using our system, stopped making those phone calls and used a combination of awareness information they received through our system to satisfy that communication need. Participants 13 and 14 when asked whether something changed in their communication while using our system reported that they used to make at least three to four phone calls during the day which they stopped during the evaluation trial. They described those phone calls as: "just making sure that..." activities are developing according to expectations. So in their case participant 14 was always first at work and would, before using our system, place a phone call at a specific time to find out whether his wife reached at her office safely and whether their child had his breakfast and had reached the daycare center. We observed that trend repeating only with couples that had really young children. For participants 13 and 14 their child is two years old. The same case was observed for participants 25 and 26 whose child is also two years old. They describe reducing phone calls that they would usually make before using our system as "not for practical reasons" and as "to know whether everything is ok". There was one more couple in our pool of participants who had two children, the elder being four years old and the younger one and a half years old. These were participants 9 and 10. When asked if they noticed whether something changed in the way the usually communicate participant 10 answers: "I think we called less each other" and participant 9 re-affirms: "we called less because we used the device", referring to our system.

Concluding, it was a deliberate functional omission, that of a notification when new awareness information was received, which led us to realize that there are two tracks of communication needed by busy parents during a day. One is the track of reassurance, a communication need which can be described as a need parents have to follow whether important activities are occurring according to plan. We have evidence from the interviews to suggest that our system helped our participants in addressing this need. The most striking evidence we presented was the replacement of phone calls which ritually occurred before the use of our system by combining awareness information offered by our system.

#### 5.6.5.6 ON AFFECTION/SHARING EXPERIENCES

Although not used very frequently, photos were for all but one couple a new feature which was integrated and appreciated in their communication. In the words of participant 7: "*what changed in our communication was that I would send him photographs*". Photos were sent in special occasions. Participant 6 recalled a day when the weather was exceptionally nice and that made him take and share a photo depicting that: "*I wanted to share a picture of the beautiful weather*". Participant 5 recalled the day their son had a swimming lesson and that made her take and share a photo depicting that. Participant 7 made photos of family members during her visit to them. Participants 25 and 26 even asked us to send them the photos that they took during the study so that they could keep them after the completion of the evaluation trial. Participants 15 and 16 both made photos and said that they would miss this feature when the evaluation trial was over. Participant 12 recalls in a diary entry: "*I was with a colleague of mine and we went for a walk and I sent <her husband, participant 11> a photo of the place*". Participant 3 recalls in a diary entry: "*Wednesday evening I wanted to send him a photo just for fun from the diner we were eating at that time.*" and in another diary entry: "*and in the afternoon I sent him a funny photo from our daughter with birthday wishes*".

Only one couple had the habit of exchanging photos before the study and appreciated that there was a dedicated space in the application interface for this reason. One couple also mentioned that they had tried in the past to send an MMS message to each other but did not manage. Due to that experience they had never tried again since; they mentioned how easy it was to share photos with FamilyAware and therefore used it. For the rest of the couples this was a new functionality. They used photos in a playful, fun way and to share nice, exceptional, out of the ordinary moments of their day, as was indeed the case in the original ASTRA study (Markopoulos et al., 2004) where participants were confronted with this functionality for the first time. However when asked whether they would continue in exchanging photos, with the exception of the couple that already did so, most of them mentioned that they would do so but not with such frequency. We should also mention that one couple (participants 9 and 10) did not use photos at all because they did not find that it added value to their communication.

Beyond photos, one participant recognized a use of the system which we did not expect. In the words of participant 4: "to show interest, then I use the device". Thus he found a means through the system we provided him to show his interest to his partner by both sharing messages of what he was doing and also requesting information from his partner about her activities. This type of expressiveness was indeed one of the motivations behind the original ASTRA applications and one of the affective benefits from communication also anticipated during the development of the ABC questionnaire (IJsselsteijn et al., 2009).

Another unexpected use of the awareness cues concerned the combination of messages with place information automatically extracted: *"It's "fun" to know where he is when he writes his messages"* (from the diary of participant 5).

# 5.6.5.7 ON THE INTEGRATION OF OUR SYSTEM IN PARTICIPANTS' DAILY RHYTHM

Another positive remark was that they neither felt the system as interrupting their activities nor as disturbing. When explicitly asked about it all but one participant responded negatively. We asked participants repeatedly whether they felt their normal daily activities had changed or whether they felt any annoyance or disturbance from carrying the system. The answer to all these questions was negative.

Female participants kept the device usually in their bag and male participants usually in their pocket. They mentioned that they would carry it with them and a few participants mentioned that while at home they would place the device at a visible place (e.g., the kitchen table) to be able to glance at it occasionally – this suggestion points to a domestic awareness system similar to that envisaged with the Whereabouts clock discussed above. Some participants at the office had that usage of our system too. They would keep the device on their desk, usually next to their computer and occasionally have a look at it. In the words of participant 8 (excerpt from diary entry): *"Yes I keep it in my office on the desk en watch it regularly."*. Participant 11 had a similar diary entry: *"Yes I checked and used all the mobile system I got provided. I looked frequently if there were any messages from <his wife, participant 12>" This is an interesting remark as related research for awareness for the workplace has typically not addressed the needs of individuals to be aware of family members while in the office.* 

#### 5.6.5.8 ON PRIVACY

We anticipated some concerns regarding privacy. As is often in this type of field studies the research context and the innocuous nature of the information presented provide some reassurance to participants (see van de Garde-Perik et al. (2008) for related discussion). As was the case with the Digital Family Portrait (Mynatt et al., 2001), the Diarist (Metaxas et al., 2007) and the Whereabouts Clock (Brown et al., 2007), no privacy concerns were reported regarding any of the awareness cues provided. Note that we explicitly inquired regarding privacy concerns separately for each awareness cue included in FamilyAware.

The place awareness cue was found privacy respecting and at the same time interesting and desirable. When explicitly asked about it all but one participant responded that they did not feel their privacy was threatened. This one participant (participant 8, a mother of three) felt in some cases uncomfortable in sharing place information. When being asked about this she explained that it was not about trying to hide something from her husband, it was rather an uncomfortable feeling of being monitored without any reason. Apart from this participant, the privacy respecting automatic sharing of place information in FamilyAware is something that goes against the design guidelines of location disclosure applications in a previous research study (lachello et al., 2005). In these guidelines it is suggested that "automatic functions that communicate on behalf of the user should not be introduced by default, but only when a real need arises" (lachello et al., 2005). Their design guidelines were developed after conducting an experience sampling study with 16 adults and the evaluation of

a location disclosure application with two families. Our participants' opinions challenge this design guideline since they felt very comfortable with the automatic exchange of place information. Clearly, privacy needs are very context sensitive and a guideline of this sort is probably not relevant for the specific communication context. On the other hand, we note that privacy safeguards were designed into the interaction with the LocationLocator as discussed earlier.

# 5.6.6 LOG RESULTS

#### 5.6.6.1 MESSAGES

The average number of messages sent by the 16 participants who used our system is 15.13 (sd: 6.33 max: 30 min: 6). That means an average of 1.08 messages per day for the period of use. At a first reading, it seems quite low. However, when compared to the mean number of SMS (0.0035) which participants reported while filling out the demographics form this appears substantially higher; participants found text as a convenient way to communicate with each other even if this was not their habit normally. This can be explained by the simplicity of the messaging application. Compared to a standard text messaging application (SMS) participants did not have to specify the recipient, which made it easier for them. Secondly, participants found it easier to enter text using the soft keyboard than text entry on the standard numeric pad of their own mobile phone. Moreover, the reassurance messages they used to send became redundant.

#### 5.6.6.2 PHOTOS

The average number of photos shared was 6.19 (sd: 4.35) and which amounts to 0.44 photos per day. Three of such photos are shown in Figure 32. Since most of the couples were not in the habit of exchanging photos through MMS messages prior to using FamilyAware we cannot really compare practices. Nonetheless our data and opinions stated during the interviews indicate that there is an unfulfilled communication need when it comes to photo sharing for this particular group very much relating to usability obstacles and vague tariff information.



Figure 32: Photos captured by participants during the evaluation trial

#### 5.6.6.3 PLACES

The mean number of places named by participants is 4.56 (sd: 2.52). A content analysis of the places named by participants shows house and workplace was inserted by all participants. However, school was not inserted by all participants. It was the participants with slightly elder children that were not interested in that particular place. Some places were named after an activity ("meeting", "walk", "sport") and other places after a person ("ingrid", "leonie", "ma", "leo en gemma", "mother"). Specific

places were also important such as the classroom ("class") for a participant who is a school teacher but from other participants too ("Bosch - room sx212", "Evoluon - ring 3", "Breda school", "town-hall", "Antonius School", "home – downstairs"). Generic places were also named ("town", "shops"). Another interesting use of place information was places visited temporarily such as: "Utrecht course", "Wicc – Wageningen".

# 5.7 DISCUSSION OF RESULTS

The unique relationship between working parents make our results valuable to researchers and designers of communication systems not just of working parents but of other groups that have a great deal of implicit knowledge of the routine of other people.

The challenge and importance of evaluating in the field has been previously reported (Carter et al., 2008). The evaluation of FamilyAware confirmed its design rationale and the choice of awareness cues it combines. In accordance with the conclusions of earlier studies (Khan and Markopoulos, 2009) we found that busy parents value awareness cues that provide an easily accessible continuous update regarding each other. The duration of the field study and the fact that participants refer to an actual experience of using such a system rather than on their own expectations and attitudes regarding this possibility lends more confidence to earlier findings. More specifically, based on the earlier studies we set out to examine whether awareness cues could address the needs for reassurance, availability awareness, coordination and expressiveness.

Consistent results have been reported in investigations concerning how families use calendars. Neustaedter et al. (2009) for example, argue that calendars are used by families as sources for awareness and coordination. An important difference that we point out with this study between the way families use calendars and awareness systems is that awareness systems, in the case of FamilyAware, are used for just-in-time coordination and not for long term coordination.

Our study raises another point of discussion for researchers of families' calendar use which is a possible direction for future research. We would argue that the use of an awareness system such as FamilyAware for an entire family, could transform monocentric families to pericentric families. Neustaedter et al. described three types of families in terms of calendaring routines: monocentric families, pericentric families and polycentric families (Neustaedter et al., 2009). In monocentric families, only the primary scheduler (mostly the mother) adds to and checks the calendar, while others learn about relevant activities through the primary scheduler who informs them. In pericentric families the primary scheduler adds to and checks the calendar, and one or more secondary schedulers infrequently add to the calendar or ask the primary scheduler about its contents. While in polycentric families the primary scheduler adds to and checks the calendar, and one or more secondary schedulers frequently add and/or update. In terms of staying aware of calendar contents the authors state that in monocentric families, secondary schedulers find out what activities are occurring by having the primary scheduler remind them of activities pertinent to them. While in pericentric families, secondary schedulers gather an awareness of families through several

means; asking the primary scheduler or infrequently checking the calendar are two means. Finally in polycentric families secondary schedulers do ask the primary schedulers. Nevertheless, they check the calendar more frequently for gaining awareness. One could argue that an awareness system such as FamilyAware when used by all family members could provide for both calendar and activity information of other family members. Such usage would most probably transform monocentric families to pericentric and pericentric families to polycentric. Would the use of awareness systems probably mean the extinction of monocentric families? That is certainly an issue for further research. Looking this issue from a different angle, one could argue that polycentric families might be the early adopters of awareness systems since they are in the habit of checking awareness information sources such as the calendar. In any case the impact of awareness systems into the ways families use calendars raises interesting points of discussion.

For coordinating tasks, a mix of explicit (messages) and implicit information (place) was useful. Moreover, an unexpected finding is the usefulness of tracking transitions in place information. Those transitions helped our participants make useful inferences in coordinating family activities. This observation implies that a short history of places that have been visited by a certain user would be needed. Currently, location sharing applications such as Yahoo's FireEagle do not include such a feature. Based on our findings we would strongly argue for having such a feature available.

It is worth commenting on the granularity of place information. With the WAC (Brown et al., 2008) the designers chose to provide only very coarse information for a fixed set of places: "work", "home", "school" and "elsewhere". The rationale of the designers of this system was stated as follows: "we reasoned that for much of family life, precise location isn't necessary". Thus coarse granularity of place information was a solution chosen to strike a compromise between providing meaningful information that was technically robust and that without threatening the privacy of users. The approach we adopted follows this rationale in that place information should be qualitative and meaningful to the family. However, FamilyAware allows potentially a much larger collection of places to be identified and a high resolution (even distinguishing between rooms in the same building floor). Eventually the mean number of places identified by participants during the two weeks of using the system was 4.56, indicating that the level of granularity of positioning information required does not need to be very high. The mean number of places named (4.56) is more than three places provided in the WAC but of a comparable order of magnitude. Place information for temporary visited places, such as destinations for short business trips or professional courses were named by our participants and were salient for inferring both availability and the approximate time of arrival back at home. Moreover, we also encountered cases where a course grain of place was not found sufficient. As noted in the results section, one participant did not find the information interesting and informative enough when his wife had named the places she visited just as "work" and "home". He needed a finer level of detail to allow him to make useful inferences for their communication. His wife on the other hand was able to make useful inference as he did provide very specific place information. Other researchers have also stated the need of family members sharing detailed place information (Greenberg et al., 2009). Through our evaluation, we corroborate this finding and we extend it by

claiming that: 1) family members will also proactively name places to help other family members infer their availability and 2) transitions between places is as important as place information itself.

A further discussion point is the use of workplace awareness. It has been reported in literature that for home inhabitants work appointments and meetings would not be something that they would be interested in (Greenberg et al., 2009). Indeed in our study, our participants did not find any particular uses of calendar information. Nevertheless, it was only a small number of them that exchanged that type of information and future studies should address that. An interesting finding though of the evaluation of FamilyAware, was that part of our participants found desktop activity information useful in determining the availability of their partner and even in choosing an appropriate medium to communicate with their partner. We would therefore argue that such a feature would be interesting to explore in future awareness systems particularly for families whose work involves frequent computer usage.

By looking at the photos exchanged through our system we can conclude that there is a usability barrier in existing systems for sharing experiences during a day. There was one couple out of the ten couples who already shared photos regularly throughout the day by using MMS. In our study we discovered that most of the couples used photos and liked that feature. Another couple mentioned that they tried sharing experiences through MMS in the past but stopped due to the difficulty of use. Even the couple who already were using MMS expressed that it was much easier to use the system we developed. It is evident that if usability would have been taken care of in MMS applications there would most probably have been an even greater usage of photos. Listening to the interviews, we can conclude that although participants mentioned that it was something "extra" and "not really necessary", all participants liked the feature a lot.

A further design aspect of FamilyAware is that of having a unique space in the interface for family communication. Nowadays designs on the mobile phones do not differentiate on the social aspects of their users. A messaging application or a photo album application for example does not make any differentiation between the messages and photos exchanged between users. From our study we find out that participants liked a lot the fact that there was a separate space in their interface for their family member. From the comments we received we can conclude that there is a need for the interface to differentiate and give the special relations of people a special place too. We observe from the usage of the system that awareness information is checked during different times and places, while having a break, while being at the office, at home but also while being mobile. This suggests that mobile awareness systems might be preferred (at least in the case of busy parents) over static displays as in Digital Family portrait (Mynatt et al., 2001) the Whereabouts Clock (Brown et al., 2007) and CareNet (Consolvo et al., 2004) since they are static.

Another issue was raised by two participants during the interviews when asked whether they would imagine using such an application in the future. Their answer was positive however they voiced concerns regarding potential erroneous or at least unintended (by them) inferences that their partner

would make about them from awareness cues. A concern for them is their ability to foresee and avoid such situations. It remains a challenge for designers of awareness systems to support sufficient awareness and control of how one is presented to connected others. The concepts designed and evaluated within this research area appear innocuous. However, this research field ought also to examine darker scenarios of using such systems and how to avoid them. Already the popular media has reported incidents where personal data published social networking websites resulted in unforeseen consequences. Thirteen cabin crew staff were sacked by Virgin Atlantic over their use of a social networking website (BBC News, 2008); a call center employee was fired after his boss read his on his Facebook profile how he was bragging about pretending to be ill and skipping (Yamine, 2008). An even more extreme case was of allegedly a man slaughtering his wife on account of her Facebook relationship status (Barak, 2008). Perhaps such cases are extreme or exaggerated by the media. They do however underline the dangers of compromising self-presentation through such media, the high emotional stakes involved when making personal information a shared and potentially public representation. These dangers should be taken into account by designers of such systems and related research ought to explore potential solutions for letting people remain in control of information they offer for awareness purposes.

# 5.8 CONCLUSIONS

We have presented the design and evaluation of FamilyAware. FamilyAware is a system providing awareness cues to support busy parents be aware of each other's whereabouts, availability, activities and emotions through a combination of automatically updated awareness cues and 'manually' captured awareness information. A study lasting four weeks (two-week long use of the system) with eight couples (16 participants) allowed us to examine the potential of this class of systems, the value they provide to people living together and the challenges facing their design and future evolution.

With our second research question (RQ1) we wanted to go beyond qualitative evidence and gather quantitative evidence to examine whether awareness systems do really add value to the communication of busy parents. A questionnaire was compiled to survey participants regarding the use of all communication media at their disposal for the last week in terms of availability, coordination, reassurance and expressing affection. The questionnaire was filled out four times: just before receiving our system (week 1), after one week of using the system (week 2), after two weeks of using the system (week 3) and a week after the intervention (week 4). Although we have mixed results to a great extent the quantitative evidence we have gathered demonstrate that our system was used by participants in their effort to infer the availability of their partner, to assist them in coordinating their tasks, to help them feel reassured about the unfolding of daily activities and to offer an alternative mean of sharing their experiences. Additionally, it is likely that these effects would have been much more significant if practical, functional problems were alleviated, such as the short battery lifetime, the fact that participants had to carry an extra mobile device and the poor GPRS signal reception from time to time.

With our second research question (RQ2) we wanted to explore whether providing richer awareness information from different sources would bring even greater added value to the use of awareness systems. The use of multiple awareness sources was still left unexplored by previous studies. According to both the quantitative and qualitative evidence we have gathered, we can conclude that multiple sources of awareness information have been particularly useful in inferring availability for communication of the other parent as well as in micro-coordinating activities. More specifically, we observed that multiple sources of awareness information allowed participants to cross-check the information they were receiving from FamilyAware and validate it. Furthermore, this cross-checking helped them make a more informed decision about how to act in order to coordinate activities.

With our third research question (RQ3) we wanted to explore how working parents would use an awareness system of multiple sources to add value to their communication needs and what would that imply for the design of such systems. When addressing that question, we have several conclusions to make.

First we observed that there appears to be two tracks of communication during the day for busy parents. One with less priority which is just to keep contact that everything is going as planned as well as in case of communicating for long term plans and then there is a track of urgent communication when information needs to be communicated quickly. That usually happens in change of plans. Moreover we conclude that our system was able to rebate in great effect the first described track.

Second, in the case of reassurance the characteristics of a medium that would support such a need is a continuous flow of information with less effort to gather the content of communication. Moreover, this finding entails redesign suggestions for other awareness systems such as the WAC and ASTRA. For example, a distinction in the interface as well as in notification options of the system might well be needed.

Third, through the log of names participants gave to places we observed the need of three types of place-naming conventions: generic, specific and temporary. Generic would be places named as "work" or "home", specific would be places named with detail such as "Bosch - room sx212" or "home – downstairs". Finally, we also observed that our participants pro-actively gave name to places that they knew they would not often visit. We classify those places as temporary. This pro-active use of place naming was used in an interesting way from the parent who was receiving that information. That parent was trying to trace the transition of such a place. For example, a participant was trying to trace the transition of such a place. For example, a participant was trying to trace the transition the parent would infer that her spouse is on his way back home. Thus, there are two interesting design conclusions in terms of the way our participants used the place information. One is the pro-active use of naming places of participants so as to help the receiving parent to know their whereabouts and the second is that the transition of places was at least as interesting to our participants as the place information itself.

In trying to sum up all the findings of this study we can conclude that the awareness information we provided was characterized by our participants both as nice and useful. More extensive field studies need to be conducted to research longer term effects of such systems since they are addressing such subtle issues as family relations.

# **CHAPTER 6: CONCLUSIONS**

"Knowledge without action is insanity and action without knowledge is vanity", Imam al-Ghazzali
#### 6.1 SUMMARY OF THE THESIS

This thesis has addressed the role of awareness systems in supporting intra-family communication. Awareness systems can be defined as a class of computer mediated communication systems that support individuals to maintain, with low effort, a peripheral awareness of each other's activities and whereabouts (Markopoulos et al., 2004). The recent development and rapid adoption (Pascu, 2008) of new communication media for sharing context information such as location (e.g. Google Latitude) and activity (e.g. Twitter) indicates that traditional communication media such as telephony, video conferencing and messaging systems, do not address the need of individuals and groups for awareness of each other. This thesis investigated thoroughly the awareness needs of busy families that are not met by traditional communication media. Busy families are defined as working parents with dependent children living under the same roof.

Figure 33 depicts the chapters' main topics and the methods and tools used for pursuing the research. Before unfolding the research endeavors, Chapter 1 introduced the scope and motivation for the work presented, a review of the existing research on awareness systems and the main research questions addressed in the thesis.



#### Figure 33: Chapter topics and used methods and tools

Chapter 2 presented the cumulative results of three studies: an interview, an evaluation of an awareness system (SchoolAware) connecting children at school with their parents and a web survey. The aim of these studies was to go beyond the evaluation of specific design concepts and to attempt to answer the following research questions:

(a) Do families want to be aware of each other throughout the day? Or, would they perhaps rather not want to know more about each other's activities and whereabouts than they already do?(b) If they do wish to have some awareness, what should they be aware of?

As a first step to assess the relevance of awareness systems for families, in-depth interviews with twenty participants were conducted, aiming to understand communication patterns of busy parents,

the content of their communication, how their communication embeds itself in their daily routine activities and uncover unmet communication needs.

The SchoolAware prototype was used as a research carrier to investigate in depth the communication needs of parents about their children's schooling life in order to further elicit requirements for awareness systems. It was felt necessary to triangulate interviews with other research methods that are more sensitive to context and that refer to a realistic experience of using awareness systems. This was especially important since one result from the interview study concerning the low acceptability of a continuously available awareness display, shed doubt upon the whole notion of awareness systems for family communication. It seemed to contradict the positive experiences reported in field trials of awareness systems in a range of earlier studies reported in this field. The prototype supported a simple awareness service communicating presence information (whether the child is in the class or not) and calendar information (scheduled school activities) from the children's school to the parents. The prototyped awareness service was set up during a two week long field trial. While the specific system tested is not proposed as the final solution they require, it embodies some important characteristics of awareness systems and as such served to solicit relevant reactions and opinions from the participants.

The web survey study presented in Chapter 2 was also designed to triangulate the findings of the interview study. However, instead of focusing on the communication between parents and children it focused on the communication of parents themselves (triangulation by method and by participants). More specifically the goal was again to find and confirm or disconfirm what awareness information do busy parents value about each other and, secondly, to examine whether information flow should be symmetric or not. To execute the web survey, related research literature was reviewed and for each research paper we examined the essence of the information the awareness system concerned was intended to communicate. In addition to the literature review, we added statements regarding information needs of busy parents that we obtained from the transcriptions of the interview study described above. In total we derived 41 statements describing awareness information that can be shared between busy parents. It is not argued or intended that this list should be complete as for different contexts and user groups one might be able to dream up an intractable range of information types. Rather this list by its construction can be taken to represent the range of possibilities explored in this research field as well as the ones we have found in this research with our user group. At this point, the issue of rating the statements was faced; it is different to actively wish to share information or to indicate that you do not mind if others view this information. Participants were asked to rate each of the above statements using the following scale to indicate their inclination towards sharing this information: "I want", "I don't want but I don't mind", "I don't want". Furthermore, another issue that was faced was that of formulating the statements; exchanging information implies both sharing and receiving. Therefore, for each piece of information we identified in the literature survey, two statements were created; one regarding the willingness to share that piece of information and one regarding the willingness to receive this information.

CHAPTER 6: CONCLUSIONS

The studies of Chapter 2 could not be considered conclusive. First because some findings contradicted each other and second because participants reported their attitudes out of context (whether that be in an in depth interview, an interview regarding a prototype or a web-survey). Thus, the Experience Sampling and Reconstruction (ESRM) method was conceived, combining characteristics of the Experience Sampling Method (ESM) (Hektner et al., 2007) and the Day Reconstruction Method (DRM) (Kahneman et al., 2004). Further, an application called Reconexp which supports the characteristics of the ESRM method was developed. On the course of developing Reconexp it became evident that there are several interesting aspects of the method that needed to be investigated. For this reason two datasets were collected; one containing logs of participant actions on the application itself and another which contained information about what busy parents would want to automatically communicate with each other during a typical day of their busy life taking their context into account. Chapter 3 presents the findings of the first data set which concerns the methodological aspects of the method.

Reconexp (reconstructing experience) aimed to reduce data loss, improve data guality and reduce the burden put upon participants. Reconexp is a distributed application partly running on a smartphone and partly on a website. On the website participants were asked to choose what information they would be generally interested in sharing with their partner. Rather than a free text entry, participants could select from an extensive list of different types of information to share. This list was the same with the one used in the web survey described in Chapter 2. After, participants were asked to provide information about their everyday context by using the website and by context we meant places and activities they visit and perform during a typical day of theirs. The chosen list of information that participants were previously asked to choose from was carried in the next step. In that next step, participants were asked to link information they would think they would want to communicate under a certain context they had already named. The information gathered on the website was synchronized on the smartphone and was handed over to a participant for one week. This device queried participants in the course of this week several times during a day on three questions. During the course of the sampling week participants were asked to log back into the website where they could review a log of their answers. In that log participants could annotate answers and more importantly they could fill out queries they were unable to answer during the sampling day on the device.

Chapter 4 presented the second data set which was collected during the Reconexp study; that of the information parents would be willing to automatically exchange with each other. The goal of this data analysis was to find out what information busy parents are interested in communicating with each other during a typical day of theirs. This analysis concluded the requirements elicitation studies for awareness systems and their use in intra-family communication. The four identified unmet communication needs were availability, coordination, reassurance and affection. Those needs were utilized to raise requirements in Chapter 5 to develop an awareness system designed for supporting the unmet communication needs of busy parents.

The requirements gathered by the previous studies provided a clear understanding of the awareness needs of busy parents. To reliably say whether an awareness system would satisfy those needs, the FamilyAware awareness system was developed and evaluated. FamilyAware combines five awareness information services that are a mix of automatically constructed awareness information and information created and exchanged with input provided for this purpose by users. The five awareness services communicated information about: place, computer activity, calendar, messages and photos. These awareness services were running on top of the Amelie platform (Metaxas et al., 2009).

Chapter 5 described the functionality and design of the system as well as the evaluation findings. The evaluation involved ten working couples (twenty participants in total) and a combination of quantitative and qualitative methods were used. Apart from the general goal of exploring the ways and reasons busy parents will use FamilyAware, the main goal of the evaluation was whether it would be used to satisfy the needs of availability, coordination, reassurance and affection which were identified in the studies mentioned in the previous chapters. An A-B-A study design was adopted to enable comparisons to be made between using the system (B) to non use (A). The evaluation included the application of a questionnaire to evaluate the four aforementioned needs: availability, coordination, reassurance and affection. The questionnaire was applied before participants acquired the prototype (A), after a week of use (B) after two weeks of use (B) and a week after the prototype was taken away (A). During the course of the study an email diary was kept by each participant, which aimed to gather more information of the uses participants found of FamilyAware. The information exchanged through the system was logged and finally debriefing interviews were held with every participating couple.

It is noteworthy to mention that for the prototypes of SchoolAware and FamilyAware the conductor of the evaluation was the designer and developer of the systems. An obvious advantage of the designer being the evaluator is saving time. In this way the time consuming process of designer briefing evaluator and evaluator communicating results to designer is eliminated. One may imagine that it might be more difficult for designers to evaluate their design in objective terms and as a consequence result in having less issues being detected. However, it has been shown in literature that designers are better at detecting problems in their own design than in someone else's (Wright and Monk, 1991). This depicts that the thorough understanding that comes from designing a system makes it easier for designers to spot problems. For the aforementioned reasons it was chosen the designer to be the evaluator as well.

Summing up all the aforementioned research we present in the following section the statement of the thesis. The main findings which support this statement follow up next.

### 6.2 STATEMENT OF THE THESIS

Ubiquitous connectivity as supported by contemporary communication applications sustaining direct communication (such as mobile phones or messaging applications) does not sufficiently address people's need for awareness of others; special purpose systems, which we refer to as awareness systems are needed to address this need.

What characterizes awareness systems is that they partially automate aspects of information capture and sharing and they support different protocols for initiation and response, providing a more flexible match to the communication patterns of users. Such systems can provide added value alongside existing media provided the following challenges are addressed during their design:

- 1. Automation of information exchange should not compete with practical information messaging that allows expressiveness and intentionality to be communicated.
- 2. The object of awareness is variable for people and contexts, so control should be provided for them to satisfy privacy needs and avoid information overload.

We unpack the thesis statement in the paragraphs that follow. Ubiquitous connectivity as supported by contemporary communication technology, such as mobile phones or instant messaging applications, does not address busy families' need for awareness of each other. Rather it is necessary to develop systems that partially automate aspects of information capture and sharing, through logging or sensing. Such systems would include for example current applications that relay positioning information to one's contacts based on GPS systems or locating the nearest cell in the GSM network. It also includes systems that rely on sensor data to construct a model of user activities within a certain space or while the user carries appropriate sensing devices (e.g., accelerometer based activity level sensing).

There are of course many challenges in the design of any communication system. Considering that the automated assembly of information characterizes the awareness systems studied in this thesis, the challenges refer to how such automation will be done in a way that fits the interpersonal communication needs of users. The thesis statement is derived from the findings of the conducted studies with busy parents, but is consistent with findings of related research in the context of other social relationships. Automation of information capture and dissemination can produce a lot of irrelevant data, so the challenge for designers is to pinpoint the information that a target user group will need. For optimizing this match to awareness information needs and for avoiding privacy concerns, control needs to be provided to users of what they wish to be aware of regarding connected others and what they wish others to be aware of regarding themselves. Moreover, automation of information exchange should not compete with practical information messaging that allows expressiveness and intentionality to be communicated. Our results show that awareness systems can play an important role to help busy parents to infer the availability of their partner,

coordinate their day to day activities, provide reassurance about other family members and exchange experiences.

In the following sections we summarize the evidence provided in favour and against the statement of the thesis, we summarize the contribution made and we sketch directions for future research.

#### 6.3 MAIN FINDINGS

Given the diversity of potential users and uses of awareness systems, evidence for the thesis was sought after in its more specific form concerning awareness for busy families.

### The use of awareness systems does not compromise the emotional aspects of communication of busy parents

The first study conducted as part of the research was an interview study presented in Chapter 2, in which parents reported that their mediated communication during the day is mainly about practical issues. In practice, that meant that they would not call each other without any reason. However, some of the communication events are not just about conveying or requesting practical information. When parents call each other just before leaving work they are not just communicating dry facts. Along with the practical information there is a parallel communication track of affective nature. By communicating practical information, such as "I am about to leave the office", "is there anything we need from the supermarket", we found that parents are at the same time communicating their emotional status, such as "did she have a busy day?", "how is he feeling", etc. In other words, any such communication act is a manifestation of intentionality. The act of making a phone-call conveys that the initiator thinks about the receiver, and puts effort to make the call. A serious challenge for the designers of Awareness Systems is that if they would automate the practical information sharing, they might deprive users of the emotional communication channel. The prospect of continuous availability of a partner through technology was met with some skepticism by interviewees who saw it as a potential distraction, as breaking a desirable separation between family and work life. These doubts and concerns were disconfirmed in the final study of this research, the field deployment and evaluation of FamilyAware described in Chapter 5. FamilyAware allowed awareness between busy parents through the day by use of handheld mobile devices and that was designed to specifically address the awareness needs of this user group. The awareness information which the system communicated did not raise such an issue. Participants who skipped routine phone calls due to the information exchanged through FamilyAware reported that they did not miss those phone calls. Therefore we can conclude that emotional aspects of the communication of busy parents are not compromised.

### Awareness systems have an important role to play in the communication between parents and children

A second important finding in the interview study was the overriding importance that working parents give to staying aware of the wellbeing of their children and sharing daily experiences and activities with them. Many observations supported this. For example, parents adjust their schedule

according to the activities of their children, they purchase communication devices for the children in order to keep in touch with them, and they mentioned that they are always available for them during working hours. The need of parental involvement and the requirements it raises for awareness systems was carried through by the prototype described in Chapter 2 which communicated awareness information from children's school to the parents at home and the office. By deploying and evaluating the prototype it was observed that more precise information regarding the children's location, richer social information and safety information are salient requirements for an awareness system wishing to connect parents with their children while the latter are at school. Nevertheless, parents expressed an important concern; they did not want to have information that would make them worry without the ability of reacting. Keeping that concern in mind we can conclude that awareness systems have an important role to play in the communication between parents and children and can enrich their communication.

# Awareness can be more detailed and refined when it helps parents monitor their children's development. The deployed system did not raise any privacy concerns between parents and children

The prototype deployed in the school study in Chapter 2, SchoolAware, was the first awareness system we evaluated. It was inspired directly by the interview study. Parents received presence and calendar information about their children for the time the latter were at school. This prototype was simple and did not explore the full potentiality of current mobile and context aware technologies; however from its conception it was designed to embody some important characteristics of awareness systems that we wished to evaluate and so served to solicit relevant reactions and opinions from parents regarding the potential role of awareness systems in their intra-family communication. Participants in the study reported in Chapter 2 valued the awareness about their child despite the simplicity of the prototype. Participants used the prototype and were able to fit its use to their daily routine (from home more rather than from the office). The prototype did not raise any privacy concerns, probably (and according to the opinions of participants) because of the young age of the children concerned who were younger than ten. More privacy concerns for children close to or during adolescence are expected. The main conclusion was that parents not only appreciated this information but also expressed the need for more detailed information and also semantically richer information that could be meaningful in the context of their parenting role, e.g., regarding the social development of the child.

#### The needs for awareness are symmetrical between busy parents

The fact that parents are interested in exchanging practical information during the day raises certain requirements for the design of both information and user interface for awareness systems. In terms of information exchange it would mean focusing on information that would support coordination of activities rather than information for conveying affection. In terms of user interface and user interaction it would mean support for efficient presentation of the information rather than an adorned presentation. Since this was an important finding which would determine the course of the

research activities we wanted more evidence to support that decision. Thus, to corroborate the finding the web survey study was executed.

The web survey study reported in Chapter 2, provided evidence that parents are interested in automatically exchanging information during the day with each other and that they are primarily interested in communicating affection and then practical information. These findings contradict the findings of the interview study in Chapter 2 which motivated a field study to allow method triangulation. From a methodological perspective, it demonstrated that the expectation of information exchange is reciprocal between parents. In other words, parents are willing to receive the same information that they are willing to send. This finding has the implication that there is no need of asking the particular group questions for both sharing and receiving information from their partner. It is noted that such symmetry in information sharing needs is not self-evident; in the generic case of groupware where there are no family ties between members, people tend to fall into asymmetrical patterns of participation, usage, and information exchange that reflect asymmetrical interests, and contexts of use (Voida et al., 2008). It corroborates survey findings by Friedman regarding privacy attitudes regarding CCTV surveillance systems, where people's attitudes about observing and being observed were found to be symmetrical (Friedman et al., 2006). This implication was carried to the Reconexp study too where it was now sufficient to ask informants about what information they wished to share, rather than distinguishing the disclosure and the acquisition of information.

Having performed the web survey study and after critically reflecting on the method used, it became clear that participants might want to share a particular awareness bit of information in a certain context, but that in another context they might not want to share the same piece of awareness information. Coupled to this concern was the disagreement of results between the interview study and the web survey study and it became evident that, when researching requirements elicitation for a context-aware system, a context-sensitive method is needed.

# A hybrid method which combines characteristics of ESM and DRM can reduce the data loss of the ESM

The Experience Sampling Method (ESM) is a context-sensitive method and a variation of the ESM was applied in Chapter 3. After quickly developing a first prototype with the use of a mobile device and piloting with four users the shortcomings of the method became apparent. Further to improvements relating to the tools, concerning usability, readability of questions and the way answers were entered, the main outcome of the pilot concerned the ESM protocol itself. This was perceived as tedious as there was a single question that was asked repeatedly soliciting repetitive answers. There were many inconvenient moments that participants could not answer questions and participants missed feedback that their input was actually used and acknowledged by the system. Thus, finding ways to involve the participants more into the study seemed to be a major requirement. The Day Reconstruction Method (DRM) has been proposed as an alternative to the ESM by Kahneman et al. (2004). Being inspired by the DRM the tool (Reconexp) which supported a hybrid method (Experience

CHAPTER 6: CONCLUSIONS

Sampling and Reconstruction Method - ESRM) was created. Two innovations were brought to the ESM. First, participants could personalize before hand the set of answers they could give when asked in situ. Second, they were able to review their answers at the end of sampling day and fill out missing points which occurred during the sampling day. The results of this hybrid method were a notable improvement upon ESM; approximately 50% of the times participants were asked in situ were not able to answer and approximately 56% of those missed queries they recovered with the help of reviewing their answers through a website. Moreover, a content analysis of the answers gave insight into the places and activities in which people were not able to respond. It is interesting to note that beyond some expected places and activities such as "car", "meeting room", "eating", "fitness training" for which participants were already expected not to be able to respond to the device, there were also places such as "train" and "home" and activities such as "check internet" and "reading news" for which participants were not able to respond as well. Thus, Reconexp also helped in providing evidence in terms of the availability of participants for experience sampling studies. However more in-depth research is needed into the ESRM method in investigating possible "postponing behavior" i.e. participants deciding to postpone their answer on the device to a later moment at the website. This would mean that the experience sampling component of the combined method, underperforms in this context and perhaps accuracy of data is lost as a whole. To eliminate such a possibility, future investigations should aim to compare ESM on its own against its adapted version with DRM inside Reconexp. While a theoretical possibility that future methodological work should investigate, it should be underlined that in the application of Reconexp in Chapter 3 no evidence was found of such postponing behavior. Although not explicitly asked about it, none of our participants mentioned such a behavior when interviewed.

### Awareness systems can support the efforts of busy parents to infer the availability of their partner, to assist them in coordinating their tasks, to help them feel reassured about the unfolding of daily activities and to offer an alternative mean of sharing their experiences without violating their privacy

After having researched the awareness needs between parents and their children with the prototype deployed in the school study, the attention was shifted to the awareness needs of the parents themselves. This shift was made so as to have an overview of all family members communication needs. The results of the analysis in terms of awareness information needs of the Reconexp study were crucial to the design and development of the second prototype, the FamilyAware awareness system. Analysis of the responses of twenty working parents who took part shows that they can benefit from automatically updated information relating to availability of each other through the day, support for micro-coordination especially surrounding dinner time and children's activities and getting reassurance regarding the well being of the family. While analyzing the situational variations of information needs, major findings are that parents seek their partner's communication availability during the day, require information to coordinate evening tasks and are prone to exchange information at home than at work.

Keeping in mind the communication needs from all the studies and particularly from the Reconexp study, FamilyAware was developed. This system was evaluated against the four communication needs mentioned above, which surfaced by the previous studies: availability, coordination, reassurance and affection. More specifically, FamilyAware was designed to display awareness cues to support busy parents to be aware of each other's whereabouts, activities, availability and emotions through a combination of automatically updated awareness cues and 'manually' captured awareness information. The conclusion that can be drawn after a month-long field study and after combining our quantitative and qualitative data was that this system was used by participants in their effort to infer the availability of their partner, to assist them in coordinating their tasks, to help them feel reassured about the unfolding of daily activities and to offer an alternative mean of sharing their experiences. It is highly probable that these effects would have been much more significant if practical, functional problems would have been alleviated, such as the short battery lifetime, the fact that participants had to carry an extra mobile device and the poor GPRS signal reception from time to time. The FamilyAware prototype brought another finding to the surface. By looking at the number of photos exchanged through FamilyAware and comparing that number to the one reported before the use of FamilyAware, we can conclude that there is an unmet communication need; that of sharing experiences through photos during a day for this group. Through the debriefing interviews it was found that there is a usability barrier in existing systems (mobile phone, email) for those people in sharing their experiences during a day. The collected data support that coarse granularity of place information was not a useful solution but rather the more specific information the better inference participants would make about the availability of their partner. Place information was privacy respecting and an unexpected finding was that transitions between places was information which participants were looking for rather than place information itself. It is unexpected because until now similar studies have implicitly suggested that place information would suffice.

### There are two tracks of communication during the day for busy parents: one with less priority which aims to evaluate whether everything is going as planned and one of urgency where information needs to be communicated quickly

Furthermore, another conclusion and point for further research is that there seem to be two tracks of communication during the day for busy parents. One with less priority which is just to keep contact that everything is going as planned as well as in case of communicating for long term plans. The second is a track of urgent communication when information needs to be communicated quickly. Moreover we conclude that FamilyAware was able to satisfy in great effect the first described track.

# User-defined place information is both privacy respecting and useful (when specific) for availability

The FamilyAware prototype brought another finding to the surface. By looking at the number of photos exchanged through FamilyAware and comparing that number to the one reported before the use of FamilyAware, we can conclude that there is an unmet communication need; that of sharing experiences through photos during a day for this group. While this is a well known and studied need, and was the topic of the earlier ASTRA system (Markopoulos et al. 2004, Romero 2007) it appears that

that there is a usability barrier in existing systems for those people in sharing their experiences during a day. The results of the study also illustrate that a statically defined and coarse granularity of location information that has been explored by related research, needs to be replaced by more specific and personalized location information that will allow users to make inferences regarding the availability of their partner. Place information was privacy respecting and an unexpected finding was that it was transitions between places that participants wished to be aware of which was as meaningful as place information itself.

#### 6.3.1 SUMMARY OF FINDINGS

- The use of awareness systems does not compromise the emotional aspects of communication of busy parents
- Awareness systems have an important role to play in the communication between parents and children
- The needs for awareness are symmetrical between busy parents
- A hybrid method which combines characteristics of ESM and DRM can reduce the data loss of the ESM
- Awareness can be more detailed and refined when it helps parents monitor their children's development. The deployed system did not raise any privacy concerns between parents and children
- Awareness systems can support the efforts of busy parents to infer the availability of their partner, to assist them in coordinating their tasks, to help them feel reassured about the unfolding of daily activities and to offer an alternative mean of sharing their experiences without violating their privacy
- There are two tracks of communication during the day for busy parents: one with less priority which aims to evaluate whether everything is going as planned and one of urgency where information needs to be communicated quickly
- User-defined place information is both privacy respecting and useful (when specific) for availability

#### 6.3.2 **REFLECTION ON FINDINGS**

Looking back at the initial research questions stated in section 1.3 one needs to address them based on the reported findings of the previous section. Thus, initially we wanted to find out whether family members do actually need and want awareness of each other provided by technological systems. In the previous section there are evidence pointing to a positive answer. First we observed while deploying quantitative methods such as the web survey in Chapter 2 and the results of the experience sampling study in Chapter 4 that parents are interested in exchanging information which will raise awareness about the place and activities of their partner. We observed in the evaluation of FamilyAware that it was used to support information needs during a typical day of theirs. FamilyAware was used to infer whether it was a good time to call and helped them in choosing the appropriate medium to contact the other partner. Further, it also added in assisting them in coordinating tasks such as getting together for dinner and partly provided a medium to help them feel reassured about the unfolding of daily activities. Although FamilyAware is just a prototype far from being a final, polished system deployed for mass use it clearly depicted the potential of such services for family members. In addition, the qualitative data gathered by the evaluation of SchoolAware also point to the same direction. In that study we found out that refined awareness information and especially information focused on the social development of their children can potentially help them in getting more involved in their children's lives. Again, as in the case of FamilyAware this is a trend that we can claim with certainty and which needs to be corroborated with longer term studies.

Reflecting on the second question of section 1.3, whether awareness systems such as SchoolAware and FamilyAware would improve people's communication and lives we can count again evidence for a positive answer. The main envisioned threats that such systems could impose are privacy related as well as distracting people from their daily activities. In both the systems we evaluated we found out that they are privacy respecting and that they do not pose a threat to emotional aspects of communication of family members. An example of such a finding is that user-defined place information in FamilyAware was found to be both privacy respecting and useful (when specific) for availability. Moreover, we realized in that evaluation that there are two tracks of communication during the day for busy parents: one with less priority which aims to evaluate whether everything is going as planned and one of urgency where information needs to be communicated quickly. We presented evidence that parents used our awareness system to rebate the former track. We argued that this usage would lead to a feeling of reassurance, a feeling of peace of mind when it comes to the well being of other family members. Such evidence illustrate the added value that could be brought into the lives of families.

The third question stated in section 1.3 considered the issues of acceptance of such systems and what would those imply for design aspects. With the experience sampling study and the two evaluation studies we presented the main reasons that families would be interested in such systems; namely: being informed and involved in children's lives, inferring the availability of the other partner, being supported in micro-coordination and feeling reassured of family members' well being. Such highlevel motives would obviously be reflected in both conceptual, interaction and user interface design of awareness systems. It is noteworthy to point out that the prototypes we developed were based in existing systems and devices which were designed and developed primarily for other uses. The desktop computer has numerous functions for families and smartphone devices which are lately becoming a market success have been primarily designed for business users. Thus, we used devices to embed awareness information interesting for family members. A question which remains open would be what would an awareness device look like? From the findings we have presented we would argue that awareness information might become the most important source for satisfying families' communication needs. That argument would raise another even more salient one: is it a mobile phone enhanced with awareness information that families need or would it be an awareness device coupled with telephone functions that families do really need? What would that mean for design

aspects such as the form of the device as well as the user interface of the device? A possible implication based on our finding of the two tracks of communication during the day for busy parents would be to provide the option to users to classify the awareness information they receive to those two tracks. Such a classification would then simplify the representation of awareness information in the interface. Furthermore, the evaluation of FamilyAware brought in the surface several design aspects that awareness systems for busy parents should adhere to. For example, it was observed that when it comes to sharing places the naming of these should be left to users. Pre-defined categories would not suffice. We found that informing about transition between places is at least as important as sharing place information and that a mix of explicit and implicit awareness information is needed.

In addressing the forth and last research question of section 1.3 we presented in Chapter 3 evidence that a hybrid method which combines characteristics of ESM and DRM can reduce the data loss of the ESM depicting the potential of such a combination. Further studies are certainly needed to corroborate both our findings as well as explore pros and cons that such a combination would bring along. A postponing behavior from the participants' part is a disadvantage which was discussed in the previous section. Seamless synchronization of data captured on the mobile device with the reconstruction features, accessing the log information from the mobile device itself, automatically notifying participants and researchers for particular events as well as features of semi-automatic analysis of the captured data are envisioned as features which would bring additional benefits to the method itself.

#### 6.4 REFLECTION ON METHODOLOGY

In this thesis several research methods were used: interviews, questionnaires, a web survey, two prototype evaluations, an experimental Experience Sampling method and combination of those. This section reflects upon their advantages and disadvantages.

Interviews afforded flexibility in investigating into depth aspects of the research question which had not been foreseen previously. For example, one participant while discussing the way she would use the mobile phone to communicate with her husband, reflected upon the patterns of mobile phone usage with her son and her elderly parents. Moreover, interviews were useful in getting first-hand knowledge in a short time of the background, practices, routines and concerns of people of the user group under investigation. On the other hand, social acceptability issues might have hindered participants from answering interview questions openly. More specifically, participants might have kept quiet about what they do not disclose to their partners through mediated communication. Further, these interviews were conducted out of context. Time is an important aspect of context and participants describe and reflect on events that have occurred in the past. Furthermore, a memory bias hinders participants to remember events that might be important at a particular time in terms of research.

Reflecting on the performed analysis of the initial interview study there is a pitfall in which researchers might fall. That is spending excessively long time to transcribe and analyze each and

every statement participants mentioned during the interview sessions. In this thesis time was even spent to create Interlysis (See appendix I) as a tool to support reporting content analysis of narrative data. Nevertheless, the initial interview study reported in this thesis shaped the direction to be followed and gave unambiguous requirements for follow-up studies and it was very useful in approaching the user group we were interested in without any preconceptions.

The web survey described in Chapter 2 was aimed at finding out whether parents want to automatically exchange awareness information between themselves during a day and what kind of information would that be. Although the data obtained was easy to analyze and very useful in tackling the issues at hand, the disadvantage of this approach was that the researchers do not have a chance to make follow up questions to the participants to discover the reasons underlying their responses. Moreover this method is by its nature executed out of context. Participants filling out the web survey had to reflect upon their past experiences to decide whether they would want to communicate a particular kind of awareness information. In our particular research interest the web survey was useful in concisely presenting to the intended users statements which represented awareness information. In this way we found the web survey to be an appropriate way to simplify a problem which is complex. Furthermore, the statements used during the survey were carried through in the experience sampling study and this way provided consistency in the different research studies.

ESRM combines characteristics of both the ESM and the DRM. It is noteworthy to mention that after taking part for one week in the study, participants could very easily reflect upon the research subject and accurately express their opinion on the research questions at stake. When a participant is reminded several times a day, even for a few seconds, about a specific question and if that continues for several days, this person can form a very accurate understanding about the experience or emotion studied. Thus, it is likely that the frequent sampling applied in this study helped informants to discover what information they most frequently want to exchange. This aspect of the ESR method scaffolds reflection making it easier and more reliable. Context sensing can also play a role in reducing participants' demands on filling out queries by querying for example when a specific event occurs.

The particular combination of characteristics of the two aforementioned methods in ESRM had promising results. It was at the same point in time that another study experimented with giving feedback to subjects participating in an experience sampling study. Their results (Hsieh et al., 2008) undoubtedly showed that this feedback had positively affected the motivation of participants. The results gathered from the ESRM study reported in Chapter 4 also point in this direction. The Reconexp tool took this idea a step further and enabled participants in filling out queries they could not answer during the day. However, this feature might be introducing a "postponing" effect: lowering the threshold for participants to omit responding since they can get a chance to retrospectively do so during the experience reconstruction phase. Whether it does introduce a postponing effect and whether this is detrimental for the utility and validity of the method is the topic for future methodological research.

A shortcoming of Reconexp for a large group of researchers is that it requires extensive technical expertise to develop and setup. Generally there are few tools which currently support researchers to conduct experience sampling studies and some experience with these tools show that they lack the maturity and robustness that is needed to support others than their developers use them in their research. Further research is needed to develop appropriate tools to support experience sampling methods and ESRM in particular.

The advantage of field testing with prototypes is that test users reflect and report upon actual rather than hypothesized experiences. Especially since it is a field trial, these experiences are in the intended context, thus lending very high ecological validity to the results. On the other hand prototype testing, as a method of testing theoretical concepts implemented in the prototype, brings about a monooperation bias. The researcher has to extrapolate from the results of the specific case and reflect them upon a class of systems. This is a general problem for the field of HCI, where prototype testing is a standard method for generating and validating knowledge. The researcher has to extrapolate from the results of the specific case and reflect them upon a class of systems. To guard against this problem, the prototype has to be representative of the class of systems studied. The researcher should be careful to distinguish empirical results referring to essential characteristics of the class of systems versus features of the special case considered. In the case of both the SchoolAware and FamilyAware prototypes we were interested in the communication needs rather than the system features. Thus it was straightforward to distinguish between the awareness needs family members have and usability problems of the specific application. Another experienced disadvantage in the evaluations described in this thesis, was the relatively difficult setup of the prototypes. The setup was both laborious and time consuming. In addition, maintenance of the prototypes required alertness and continued support apart from time and effort. Nonetheless, field testing is extremely useful in finding out the nuances of specific contexts of usages participants have as well as the underlying reasons for usage.

Triangulating several methods to address a research question was found to be particularly conducive to explorative research. In the case of FamilyAware, one of the research questions was what uses would participants find for the system; the email diary helped gather data over time which participants would have forgotten while during the interview participants could outline their overall experience of the system. Thus, when an innovation needs to be explored from different perspectives rather than a well defined research question it would be particularly useful to utilize several methods during the research study. Therefore this thesis argues for the use of triangulating qualitative and quantitative methods in the case of exploring new systems. More so in cases in which the research objective is systems which are envisioned to be integrated in the daily lives of people. In such a case there is a great number of factors which is going to affect the usage and experience of the system. There is a higher probability in revealing those factors by applying different methods at the same time.

#### 6.5 LIMITATIONS

In the beginning of the project in 2004, hardware, software and service limitations were quite considerable. PDA's were far from affordable to most people and especially to the user group we were targeting and internet access on mobile phone devices seemed like an excess for them let alone its limited technical characteristics at that time. Programming on mobile devices was also challenging. Compact Framework .NET SP3 of Microsoft was released in 2005; this was a significant development as it allowed low level programming, e.g., controlling the WiFi adapter, which was an unrealistic challenge using the Java virtual machines of that time. However, after four years, the scene has completely changed. The FamilyAware prototype was executed on Windows Mobile 6 devices which had a 400MHz processor coupled with a 2GB of external SD flash memory card. In terms of programming on mobile platforms tools such as .NET Compact Framework in combination with Microsoft Visual Studio provide a complete solution to developers. At the time of the evaluation of FamilyAware, Vodafone was offering pre-paid SIM cards with one month unlimited internet over UMTS for a small fee. Without this radical advance of hardware devices, software platforms and mobile internet services the development and evaluation of FamilyAware would have been much more challenging. These developments also mean that at this point in time all technical aspects are mature for the development and growth of awareness systems.

Nevertheless, there are still many improvements that can make the mobile devices more accessible for developers and designers. A problem that was faced during the research studies was that participants' own devices could not be used to run our prototypes. This would have been desirable to avoid purchasing and supplying devices in order to execute the research, because it would not burden users with the burden of carrying one more mobile device for the purposes of the study alone and it would lend more ecological validity to the results as it would be more faithful to the intended usage of this type of technology. This limitation was either because participants did not have Windows Mobile devices or because they did not have internet on their mobile phone contract. Even if participants would have internet on their mobile devices there were some participants that had to travel abroad, mostly in neighboring countries. That meant roaming costs would have burdened the participant. This limitation is though not threatening to the conclusions of this study: running our experiments without requiring participants to carry an extra device, is likely to have lead to even more favorable results and intense usage patterns than those observed. Further, as mobile access to internet is becoming more widespread the applications studied here will become relevant to a larger number of people.

Another limitation faced in the research reported was that even if mobile devices have become considerably affordable in comparison to two years earlier, their price is still not negligible. That meant for our studies a limited number of participants since only a limited set of devices were available for our study. This is an obvious limitation which partly affects the generalization of findings. A greater number of devices would mean a greater number of participants and therefore more data to support our findings.

Moreover, as it was described in Chapter 5 a longer term evaluation in the field might have been more revealing and reliable. The observations of the questionnaire data collected during the FamilyAware evaluation evidently showed that the system had a potential in addressing the communication needs it was designed for. At the same time though it would be interesting to run the study for even longer to be able to discriminate effects of using the system from the effects resulting from the study itself.

As previously stated in Chapter 1, when this research endeavor began systems and applications targeted in supporting people to share their context information and in that way make them more aware of each other, were still in their infancy. Nowadays, services such as Twitter, Facebook and Google Latitude that can be characterized as awareness systems are gaining a lot of popularity. The users of Twitter can share their activities with other people. Users of Facebook can publish their photos, exchange messages and all sorts of interests and activities with other Facebook users. More recently, Google Latitude gives the opportunity to its users to share their location with family and friends. This variety of services is comparable with the notion of awareness systems we have introduced in this thesis and probably have similar motivations in supporting unmet communication needs of people. However, the work presented in this thesis has pushed the functionality of such services further by partly automating the capture and dissemination of awareness information. Moreover, this thesis addresses the specific communication needs of busy families and evaluates through prototypes whether those needs are met or not by such systems. Thus, this thesis brings a different perspective, by addressing unmet communication needs of people, into the factors which would play a crucial role in the acceptance of such systems.

A further limitation is that although in Chapter 3 we presented evidence favoring a combination of the ESM with the DRM it is only one study and further studies need to be conducted to confirm our findings. Limitations might at the same time inspire future research directions. The next section addresses those directions.

#### 6.6 FUTURE WORK

In terms of future work, there are some directions proposed in this section that the research work described in this thesis can expand.

#### 6.6.1 INVESTIGATING OTHER GROUPS

This research focused on the communication needs and the application of awareness systems in a family which lives under the same household. Participants in the studies reported were parents who were both working and had at least one dependent child. The enormous success of other communication media such as Instant Messaging and social networking websites such as Facebook or MySpace that are popular among teenagers and young adults make those groups particularly interesting in investigating what uses they will have for awareness systems. In speculating for the particular group it could well be that information pertaining to availability might be of less

importance than micro-coordination of leisure activities. A need for using the information with different media, in mashing-up awareness information with other information sources to create new applications can also be expected. Awareness systems might be particularly interesting for such groups in social gatherings such as concerts or movie theaters. More specifically, awareness systems can help in coordinating activities and sharing photographs or videos.

Another potentially interesting group for investigating further is family members who are on business trips. In the interview it was found that parents, when being on a business trip, do not contact their family members back home as frequently as they would have wished to because of time difference and busy schedules. When on a business trip the need for knowing whether everything is fine back home is greater. The need for sharing the experiences at the visiting place is also strong. Combined to the fact that the person being on a business trip has less time to spend for capturing and sharing experiences makes investigating the role of awareness systems in such a context even more interesting.

#### 6.6.2 DESIGN EXPLORATIONS

In the two awareness system prototypes which were presented in this thesis the emphasis has been on the information content and the information exchange mechanisms rather than the presentation of the information. There is a plethora of alternative solutions that could be applied to visualize and interact with awareness information. The design solutions can vary from conceptual to graphic design aspects.

An example of such a solution was conceived during the period of the reported research activities. Inspired by the Digital Diarist (Metaxas et al., 2007) and relating to parents' routinely transitions from work to home the concept of reading out awareness information was conceived. The idea would be that the awareness information gathered during the day of family members would be read out by a mobile device with the help of a text-to-speech engine. That could for example happen while one drives back home. This idea was not pursued further but could be very relevant for mobile users. There are limitless designs that can be created for presenting awareness information in a context appropriate manner and future design work could explore this solution space more thoroughly.

Another important finding for the design of such communication systems which was initially seen in the interview study and which repeated in all other studies was that for most of our participants dinner time was seen as an important communication event within family life. Parents made an extra effort in order to make dinner time as pleasant as possible for everybody, particularly for younger children. At dinner time they tried to encourage children to tell what they have experienced or have done at school or with their friends during the day. In general, we saw that parents avoided talking about work related issues although that was not always possible. In terms of requirements for awareness systems this means that dinner time might be utilized by awareness systems to enrich existing communication between family members. Exploring solutions for supporting the dinner ritual is a potentially interesting problem domain to explore. Going beyond the presentation of awareness information, there are limitless opportunities for designing appliances as well. With the FamilyAware prototype, which was an exclusive "awareness device" for the participants it was preferred by most of the participants to have to carry one device. This is an influential trend and line of thinking (Oulasvirta et al., 2007) which embeds awareness information in elements of a communication application, e.g., buddy lists, contact lists, screen savers. However, this leaves out opportunities for the design of special purpose appliances that will provide access to awareness information services. In the case of FamilyAware an off-the-shelve smartphone device was used as an awareness system. It might be the case that a different form and shape of the device and a different presentation of awareness information would have been preferred by participants. With the advent of smartphone devices which resemble more a computer in a small shape rather than a phone and with the creation of awareness services we argue that the future communication device would be an awareness device with phone functionality rather than a phone device enhanced with awareness cues.

### 6.6.3 INVESTIGATING THE RELATION BETWEEN FAMILY COMMUNICATION MODELS AND THEIR RELEVANCE FOR THE ACCEPTANCE OF AWARENESS SYSTEMS

The research on supporting intra-family communication with awareness systems largely takes an undiscriminating perspective of families. As the interpersonal relations between family members may vary quite significantly it is not necessarily the case, that inquiries like our interview study or field testing of awareness systems will lead to valid conclusions, if the diversity of families and the interpersonal relations is not addressed. A model which would be particularly useful in such a case would be the one presented in Figure 34 by Koerner and Fitzpatrick (2004). This model distinguishes four types of families, according to two dimensions: I. Conversation Orientation and II. Conformity Orientation (Figure 34).



Figure 34: The model of family communication by Koerner and Fitzpatrick (2004) distinguishes four types of families

Conversation Orientation is the degree to how open family members are to discuss matters. Conformity Orientation is the degree to how flexible family members are in making their own attitudes, values and beliefs. The effect of those dimensions is a classification of families according to their communication. There are four family types classified according to their communication style:

- Pluralistic: Families that favor open discussion and individual decision making.
- Consensual: Families that favor open discussion but parents try to influence the decisions and opinions of their children.
- Laissez-faire: Families that do not appreciate open discussions and their communication is not that interactive. Parents are not that involved in the decisions of their children.
- Protective: Families that do not appreciate open discussions and parents try to influence the views and opinions of their children.

It must be clarified that this classification does not characterize families into better or worse. Rather, it identifies differences of face to face communication in families. Future studies could explore how communication needs relate to this model and whether the type of family helps in predicting the use and acceptance of awareness systems. A plausible hypothesis is that Pluralistic and Consensual families would be more likely to adopt such solutions. The members of such families engage in open and frequent conversations; parents spend time and energy to listen to their children and to explain their own opinions. Children are encouraged to express their experiences and views. Therefore such a "communication atmosphere" seems to relate more to the frequent and desired use of communication systems. Future research will have to, at some point, investigate whether such a link exists and if so how does it impact the acceptance of awareness systems.

#### 6.6.4 CULTURAL DIFFERENCES

The research reported in this thesis took place in a certain culture; the Dutch culture. Cultural aspects have certainly shaped the research results. The structure of family, social values and expectations as well as every day working and living patterns are parts of culture and undeniably shape the communication needs of families. The family structure in other culture differs. For example in India as well as in Japan grandparents typically live at home. Such a structure shapes family routines, for example about managing children's activities. Therefore, such a different structure from the structure encountered in a typical Dutch family would have an effect in the communication needs of family members and therefore in their awareness needs. Moreover, in other cultures, having dinner with the whole family is not the norm (e.g. in Singapore children are getting dinner with the nanny rather than with the family), so less in conflict with the end of the working days. Cross cultural studies of prototypes such as FamilyAware or SchoolAware would be able to shade more light in the nuances of culture and awareness system's role into intra-family communication needs.

# 6.6.5 ROOM FOR IMPROVEMENT IN TOOLS FOR ELICITING USER REQUIREMENTS IN CONTEXT

Finally, an important finding of the Reconexp study is that there is a lack of tools for supporting researchers in conducting long term experience sampling surveys. The only tool available now is MyExperience which is also under development and although it features several important properties it is still far from being easily deployed by researchers. The main reason for being easily adopted is that it needs extensive technical expertise. The features of a future experience sampling tool have been extensively presented in Chapter 3.

### **BIBLIOGRAPHY**

- Anderson, I. and Muller, H.(2006). Qualitative positioning for pervasive environments. Third International Conference on Mobile Computing and Ubiquitous Networking (ICMU 2006), London, UK, 10-18.
- Abowd, G. D. and Mynatt, E. D. 2000. Charting past, present, and future research in ubiquitous computing. ACM Trans. Comput.-Hum. Interact. 7, 1 (Mar. 2000), 29-58. DOI= http://doi.acm.org/10.1145/344949.344988
- Barak Sylvie, Man jailed for life for hacking wife to death over Facebook relationship status, the Inquirer, 17 October 2008, http://www.theinquirer.net/inquirer/news/209/1008209/man-jailed-life-hacking-wife (last accessed on 30/12/08)
- van Baren, J., IJsselsteijn, W.A., Romero, N., Markopoulos, P., de Ruyter, B.: Affective Benefits in Communication: The development and field-testing of a new questionnaire measure. PRESENCE, Aalborg, Denmark, October 2003
- Barrett, L.F. and Barrett, D.J. 2001. An Introduction to Computerized Experience Sampling in Psychology. Social Science Computer Review., V. 19, No. 2, S01, pp. 175-185.
- Barrett, L.F.,&Barrett, D.J. 2005. ESP, the experience sampling program. http://www.experience-sampling.org. (last accessed: 21-02-09)
- Bauch, J.P.: Applications of technology to linking schools, families and students. Proceedings of the Families, Technology, and Education Conference. Retrieved Oct. 1, 2001
- Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. Psychological Bulletin, 117, 497-529
- BBC News, Crew sacked over Facebook posts, 31 October 2008, http://news.bbc.co.uk/2/hi/uk\_news/7703129.stm (last accessed on 30/12/08)
- van Bel, D. T., Smolders, K. C. H. J., IJsselsteijn, W. A., & De Kort Y. A. W. (2009). Social connectedness: concept and measurement. In: V. Callaghan, A. Kameas, A. Reyes, D. Royo & M. Weber (pp.67-74). Amsterdam: IOS Press. Proc. of the 5th International Conference on Intelligent Environments.
- Benford, Steven D., John M. Bowers, Lennart E. Fahlén, and Chris Greenhalgh (1994): Managing mutual awareness in collaborative virtual environments. In G. Singh, S.K. Feiner, and D. Thalmann

(eds.): VRST'94: Proceedings of the ACM SIGCHI Conference on Virtual Reality and Technology, Singapore, 23–26 August 1994. New York: ACM Press, pp. 223–236.

- Bentley, F. and Metcalf, C. Sharing Motion Information with Close Family and Friends. Proc. of CHI, ACM Press (2007), pp. 1361 1370.
- Blanchard, J.: The family-school connection and Technology. Paper presented at the Families, Technology, and Education Conference, Washington, DC. 1997
- Bly, Sara, Steve R. Harrison, and Susan Irwin (1993): Media spaces: Bringing people together in a video, audio, and computing environment. Communications of the ACM, vol. 36, no. 1, January 1993, pp. 28–47.
- Brave, S. & Dahley, A. inTouch: A Medium for Haptic Interpersonal Communication. Proc. CHI 1997, 363-364
- Brown, B. A. T., Taylor, A. S., Izadi, S., Sellen, A., Kaye, J. and Eardley, R. Locating family values: A field trial of the whereabouts clock. In J. Krumm, G. D. Abowd, A. Seneviratne, and T. Strang, editors, Ubicomp, volume 4717 of Lecture Notes in Computer Science, pages 354{371. Springer, 2007.
- Cadiz, J. J., Venolia, G., Jancke, G., and Gupta, A. 2002. Designing and deploying an information awareness interface. Proceedings CSCW '02. ACM, New York, 314-323.
- Carter, S. and Mankoff, J. 2005. When participants do the capturing: the role of media in diary studies. Proceedings CHI '05. ACM, New York, NY, 899-908.
- Carter, S., Mankoff, J., and Heer, J. 2007. Momento: support for situated ubicomp experimentation. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (San Jose, California, USA, April 28 - May 03, 2007). CHI '07. ACM, New York, NY, 125-134. DOI= http://doi.acm.org/10.1145/1240624.1240644
- Carter, S., Mankoff, J., Klemmer, S. and Matthews, T.. Exiting the cleanroom: On ecological validity and ubiquitous computing. HCl Journal , Vol. 23, No. 1. (2008), pp. 47-99.
- Caughlin, J.P. and Petronio, S.: chapter: "Privacy in Families". In: Vangelisti, A.L., "Handbook of family communication", p. 379. Lawrence Erlbaum Associates. 2004
- Consolvo, S. and Walker, M. 2003. Using the Experience Sampling Method to Evaluate Ubicomp Applications. IEEE Pervasive Computing 2, 2 (Apr. 2003), 24-31. DOI= http://dx.doi.org/10.1109/MPRV.2003.1203750

- Consolvo, S., Roessler, P., Shelton, B.E., "The CareNet Display: Lessons Learned from an In Home Evaluation of an Ambient Display," Proceedings of the 6th Int'l Conference on Ubiquitous Computing: UbiComp '04, (Sep 2004), pp.1-17.
- Consolvo, S., Smith, I., Matthews, T., LaMarca, A., Tabert, J., Powledge, P. Location Disclosure to Social Relations: Why, When, & What People Want to Share. In Proc. of the Conference on Human Factors and Computing Systems: CHI 2005, 81–90, ACM Press, 2005.
- Consolvo, S., Harrison, B., Smith, I., Chen, M.Y., Everitt, K., Froehlich, J. and Landay, J.A.. "Conducting In Situ Evaluations for and with Ubiquitous Technologies," International Journal of Human-Computer Interaction, Vol. 22, No. 1-2, (2007), Pages 103-118.
- Conversy, S., Roussel, N., Hansen, H., Evans, H., Beaudouin-Lafon, M. & Mackay, W. (2003) VideoProbe. In Proc. IHM'03.
- Cook, T.D. and Campbell, D.T. 1979, Quasi-Experimentation: Design and Analysis Issues for Field Settings. Houghton Mifflin, Boston
- Crabtree, A., Hemmings, T., Rodden, T., & Mariani, J. Informing the development of calendar systems for domestic use, Proc. ECSCW '03, Kluwer Academic Publishers, (2003), 119-138.
- Dick, B., (2005) "Grounded theory: a thumbnail sketch". [On line] Available at http://www.scu.edu.au/schools/gcm/ar/arp/grounded.html (accessed at 31/08/05)
- de Sá, M., Carriço, L., Duarte, L., and Reis, T. 2008. A framework for mobile evaluation. In CHI '08 Extended Abstracts on Human Factors in Computing Systems (Florence, Italy, April 05 - 10, 2008). CHI '08. ACM, New York, NY, 2673-2678. DOI= http://doi.acm.org/10.1145/1358628.1358743
- Dourish, P. and Bellotti, V. 1992. Awareness and coordination in shared workspaces. In Proceedings of the 1992 ACM Conference on Computer-Supported Cooperative Work (Toronto, Ontario, Canada, November 01 - 04, 1992). CSCW '92. ACM, New York, NY, 107-114. DOI= http://doi.acm.org/10.1145/143457.143468
- Dourish, P. and Bly, S. 1992. Portholes: supporting awareness in a distributed work group. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (Monterey, California, United States, May 03 - 07, 1992). P. Bauersfeld, J. Bennett, and G. Lynch, Eds. CHI '92. ACM, New York, NY, 541-547. DOI= http://doi.acm.org/10.1145/142750.142982
- Eggen, B., and van Mensvoort, K., Making sense of what is going around, in Awareness systems, Springer, HCIS, ISBN: 978-1-84882-476-8

- Erickson , T., Wendy A. Kellogg, Social translucence: an approach to designing systems that support social processes, ACM TOCHI, v.7 n.1, p.59-83, March 2000
- Fraser, K., Rodden, T. and O'Malley, C. (2006) Home-school Technologies: considering the Family. IDC '06, pp. 153-156
- Friedman, Batya, Kahn, Peter H., Hagman, Jennifer, Severson, Rachel L. & Gill, Brian (2006). The Watcher and the Watched: Social Judgments About Privacy in a Public Place. Human-Computer Interaction, 21 (2), 235-272.
- Froehlich, J., Chen, M. Y., Consolvo, S., Harrison, B., and Landay, J. A. 2007. MyExperience: a system for in situ tracing and capturing of user feedback on mobile phones. In Proceedings of the 5th international Conference on Mobile Systems, Applications and Services (San Juan, Puerto Rico, June 11-13, 2007). MobiSys '07. ACM, 57-70. DOI= http://doi.acm.org/10.1145/1247660.1247670
- Froehlich, J., Chen, M., Smith, I., and Potter, F. Voting With Your Feet: An Investigative Study of the Relationship Between Place Visit Behavior and Preference. Proceedings of Ubicomp 2006, Orange County, California, 2006.
- van de Garde-Perik, Markopoulos, P., de Ruyter, B., Eggen, B., IJsselsteijn, W.A, (2008). Investigating privacy attitudes and behavior in relation to personalization. Social Science Computer Review, Spring 2008. Vol.26, No.1, SAGE 20-44.

Gaver, B. 2002. Provocative Awareness. Comput. Supported Coop. Work 11, 3 (2002), 475-493.

- Greenberg, S., Neustaedter, C., Elliot, K., 2009, Awareness in the home, in Awareness systems, Springer, HCIS, ISBN: 978-1-84882-476-8
- Greene, J. and d'Oliveira M., Learning to user statistical tests in psychology: a student's guide, Open University Press, 1982, ISBN: 0-335-10177-1
- Gutwin, Carl and Saul Greenberg (2002): A descriptive framework of workspace awareness for realtime groupware. Computer Supported Cooperative Work. The Journal of Collaborative Computing, vol. 11, nos. 3–4, 2002.
- Hassenzahl, M. 2008. User experience (UX): towards an experiential perspective on product quality. In Proceedings of the 20th international Conference of the Association Francophone D'interaction Homme-Machine (Metz, France, September 02 - 05, 2008). IHM '08, vol. 339. ACM, New York, NY, 11-15. DOI= http://doi.acm.org/10.1145/1512714.1512717

- Hektner, J. M., Schmidt, J.A. and Czikszentmihalyi, M., "Experience Sampling Method: Measuring the quality of everyday life.", Sage, 2007, ISBN: 1412925576.
- Hindus, D., S.D. Mainwaring, N. Leduc, A.E. Hagström, and O. Bayley, "Casablanca: Designing Social Communications Devices for the Home", Proc. 2001 ACM Conf. Human Factors in Computing Systems (CHI 2001)
- Holmquist, L.E., Falk J. and Wigström, J. Supporting Group Collaboration with Inter-Personal Awareness Devices. Personal Technologies, Vol. 3, No s. 1& 2, pp. 13-21, 1999
- Hong, J.I. and Landay, J.A.(2004) "An Architecture for Privacy- Sensitive Ubiquitous Computing". in Mobisys'04. Boston, MA. pp. 177-189
- Hoover-Dempsey, K. V., Walker, J. M. T., Sandler, H. M., Whetsel, D., Green, C. L., Wilkins, A. S., & Closson, K. E.: Why do parents become involved? Research findings and implications. Elementary School Journal, 106(2); (2005) 105-130
- Hsieh, G., Li, I., Dey, A., Forlizzi, J., and Hudson, S. E. 2008. Using visualizations to increase compliance in experience sampling. In Proceedings of the 10th international Conference on Ubiquitous Computing (Seoul, Korea, September 21 - 24, 2008). UbiComp '08, vol. 344. ACM, New York, NY, 164-167. DOI= http://doi.acm.org/10.1145/1409635.1409657
- Hsiu-Fang Hsieh and Sarah E. Shannon, Three Approaches to Qualitative Content Analysis Qual Health Res, Nov 2005; 15: 1277 - 1288.
- Hudson, J. M., Christensen, J., Kellogg, W. A., and Erickson, T. 2002. "I'd be overwhelmed, but it's just one more thing to do": availability and interruption in research management. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems: Changing Our World, Changing Ourselves (Minneapolis, Minnesota, USA, April 20 25, 2002). CHI '02. ACM, New York, NY, 97-104. DOI= http://doi.acm.org/10.1145/503376.503394
- Hutchinson, H., Mackay, W., Westerlund, B., Bederson, B. B., Druin, A., Plaisant, C., Beaudouin-Lafon, M., Conversy, S., Evans, H., Hansen, H., Roussel, N., and Eiderbäck, B. 2003. Technology probes: inspiring design for and with families. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (Ft. Lauderdale, Florida, USA, April 05 - 10, 2003). CHI '03. ACM, New York, NY, 17-24. DOI= http://doi.acm.org/10.1145/642611.642616 ACM Press, New York, 2001, pp. 325–332.
- Iachello, G., Smith, I., Consolvo, S., Chen, M., and Abowd, G. D. 2005. Developing privacy guidelines for social location disclosure applications and services. In Proceedings of the 2005 Symposium on Usable Privacy and Security (Pittsburgh, Pennsylvania, July 06 - 08, 2005). SOUPS '05, vol. 93. ACM, New York, NY, 65-76. DOI= http://doi.acm.org/10.1145/1073001.1073008

- IJsselsteijn, W., van Baren, J., Markopoulos, P., Romero, N., de Ruyter, B., 2009, Measuring affective benefits and costs of awareness systems, in Awareness systems, Springer, HCIS, ISBN: 978-1-84882-476-8
- Intille, S. S., Rondoni, J., Kukla, C., Ancona, I., and Bao, L. 2003. A context-aware experience sampling tool. In CHI '03 Extended Abstracts on Human Factors in Computing Systems (Ft. Lauderdale, Florida, USA, April 05 - 10, 2003). CHI '03. ACM, New York, NY, 972-973. DOI= http://doi.acm.org/10.1145/765891.766101
- ISO 13407 (1999). Human-centred design processes for interactive systems.
- Isomursu, M., Tähti, M., Väinämö, S., and Kuutti, K. 2007. Experimental evaluation of five methods for collecting emotions in field settings with mobile applications. Int. J. Hum.-Comput. Stud. 65, 4 (Apr. 2007), 404-418. DOI= http://dx.doi.org/10.1016/j.ijhcs.2006.11.007
- Jiang X., Hong J., Landay J. " Approximate Information Flows: Socially-Based Modeling of Privacy in Ubiquitous computing" in proceedings of Ubicomp2002, LNCS, 2498, Springer Verlag, pp 176-193
- JF Schouten School database of participants, http://ppdb.tm.tue.nl/ (last accessed on 26/12/08)
- Kahneman D., Krueger A.B., Schkade D.A., Schwarz N., Stone A.A., A Survey Method for Characterizing Daily Life Experience: The Day Reconstruction Method, Science 306, 1776 (2004).
- Kapadia, R. and Andersson, G., "Statistics explained", Chapter 11: "Making Inferences", p. 200, 1987, Published by: Ellis Horwood Limited
- Kapoor, A. and Horvitz, E. 2008. Experience sampling for building predictive user models: a comparative study. Proceedings CHI '08. ACM, New York, 657-666.
- Kelle, U., Chapter 30 in: Clive Seale, Giampietro Gobo, Jaber F Gubrium and David Silverman, "Qualitative Research Practice", Sage, 2004.
- Khalili, A. and Connelly K. Context-aware telephony: privacy preferences and sharing patterns. CSCW 2006.
- Khan, V.J., Markopoulos, P., Mota, S., IJsselsteijn, W., de Ruyter, B., Intra-family communication needs; how can Awareness Systems provide support?, Proc. 2nd International Conference on Intelligent Environments (IE06)

- Khan, V.J., Markopoulos, P., Eggen, B., On the Role of Awareness Systems for Supporting Parent Involvement in Young Children's Schooling, In IFIP, Volume 241/2007, HOIT 2007, Springer, p. 91– 101.
- Khan, V.J., Markopoulos, P., de Ruyter, B., IJsselsteijn, W., Expected Information Needs of Parents for Pervasive Awareness Systems, Proc. Of AmI-07, Darmstadt, Germany, 7-10 September, 2007. LNCS 4794/2007 332-339.
- Khan, V.J. and Markopoulos, P. 2009. Busy families' awareness needs. Int. J. Hum.-Comput. Stud. 67, 2 (Feb. 2009), 139-153. DOI=http://dx.doi.org/10.1016/j.ijhcs.2008.09.006
- Koerner, A.,F. and Fitzpatrick, M.,A., Communication in intact families, in Vangelisti, A. (2004), Handbook of family communication. Mahwah, NJ: Erlbaum Associates
- Kubey, R., Larson, R., Csikszentmihalyi, M., (1996) Experience sampling method. Applications to communication research questions. Journal of Communication; Spring 1996; 46, 2; 99-120
- Liechti, O., Ichikawa, T., 2000. A digital photography framework enabling affective awareness in home communication. Personal Technologies 4,6–24.
- Lindlof, T.R., Taylor, B.C., (2002) Qualitative Communication Research Methods, Second Edition, Sage Publications.
- Ling, R. 2004. In: "The Coordination of Everyday Life", Chapter 4 In: "The Mobile Connection: the cell phone's impact on society", Elsevier, ISBN: 1-55860-936-9.
- Ludford, P. J., Priedhorsky, R., Reily, K., and Terveen, L. 2007. Capturing, sharing, and using local place information. Proceedings CHI '07. ACM, 1235-1244. DOI= http://doi.acm.org/10.1145/1240624.1240811
- Mackay, W. E. and Fayard, A. 1997. HCI, natural science and design: a framework for triangulation across disciplines. In Proceedings of the 2nd Conference on Designing interactive Systems: Processes, Practices, Methods, and Techniques (Amsterdam, The Netherlands, August 18 20, 1997).
  S. Coles, Ed. DIS '97. ACM, New York, NY, 223-234. DOI= http://doi.acm.org/10.1145/263552.263612
- Markopoulos, P., Bongers, B., Van Alphen, E., Dekker, J., Van Dijk, W., Messemaker, S., Van Poppel, J., Van der Vlist, B., Volman, D., and Van Wanrooij, G. 2006. The PhotoMirror appliance: affective awareness in the hallway. Personal Ubiquitous Comput. 10, 2-3 (Jan. 2006), 128-135. DOI= http://dx.doi.org/10.1007/s00779-005-0007-x

- Markopoulos, P., (2005) Designing ubiquitous computer human interaction: the case of the connected family. in Isomaki, H., Pirhonen, A., Roast, C., Saariluoma, P., (Eds.) Future Interaction Design. Springer, 125-150.
- Markopoulos, P., Romero, N., van Baren, J., IJsselsteijn, W., de Ruyter, B., and Farshchian, B. 2004. "Keeping in touch with the family: home and away with the ASTRA awareness system". In: Proceedings CHI '04, ACM Press, p. 1351-1354.
- Marmasse, N., Schmandt, C., Spectre, D. (2004) WatchMe: communication and awareness between members of a closely-knit group. In: Proc. Ubicomp 2004
- McEwan, G. and Greenberg, S. 2005. Supporting social worlds with the community bar. In Proceedings of the 2005 international ACM SIGGROUP Conference on Supporting Group Work (Sanibel Island, Florida, USA, November 06 - 09, 2005). GROUP '05. ACM, New York, NY, 21-30. DOI= http://doi.acm.org/10.1145/1099203.1099207
- Mehl, M. R., Pennebaker, J. W., Crow, M. D., Dabbs, J., & Price, J. H. 2001. The Electronically Activated Recorder (EAR): A device for sampling naturalistic daily activities and conversations. Behavior Research Methods, Instruments, and Computers, 33, 517-523.
- van Mensvoort., K. Datafountain: Money translated to water, http://www.koert.com/work/datafountain/ (last accessed on: 19-03-2009)
- Metaxas, Markopoulos, P., (2008) 'Aware of What?' A Formal Model of Awareness Systems That Extends the Focus-Nimbus Model, Springer, LNCS 4940: 429-446. DOI: 10.1007/978-3-540-92698-6
- Metaxas, G., Markopoulos, P., Aarts, E., (2009). Amelie: a recombinant computing framework for ambient awareness. To appear in, de Ruyter, B., Tscheligi, M., Eds., Proceedings AMI'09, 3rd European Conference on Ambient Intelligence November 18th - 21st 2009, Salzburg, Austria, Springer LNCS.
- Metaxas, G., Metin, B., Schneider, J., Markopoulos, P., De Ruyter, B., (2007) Daily Activities Diarist: Supporting Aging in Place with Semantically Enriched Narratives, INTERACT 2007, Springer, LNCS 4663: 390-403.

Morris, M., E. Social Networks as Health Feedback Displays. IEEE Internet Computing 9, 5 (2005), 29-37.

Mynatt, E. D., Rowan, J., Craighill, S., and Jacobs, A. 2001. Digital family portraits: supporting peace of mind for extended family members. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (Seattle, Washington, United States). CHI '01. ACM, New York, NY, 333-340. DOI=http://doi.acm.org/10.1145/365024.365126

- Nagel, K., Kidd C.D., O'Connell, T., Dey, A., Abowd, G.D., "The Family Intercom: Developing a Context-Aware Audio Communication System", Ubicomp 2001
- Neustaedter, C., Elliot, K. and Greenberg, S. Interpersonal Awareness in the Domestic Realm. Proc. OZCHI. (Sydney, Australia), (2006)
- Neustaedter, C., Brush, A. J., and Greenberg, S. 2009. The calendar is crucial: Coordination and awareness through the family calendar. ACM Trans. Comput.-Hum. Interact. 16, 1 (Apr. 2009), 1-48. DOI=http://doi.acm.org/10.1145/1502800.1502806
- Noldus, Handheld observation system, product brochure http://www.noldus.com/webfm\_send/78 (last accessed: 21-02-09)
- Olson, J., J. Grudin, and E. Horvitz. A study of preferences for sharing and privacy. In Proceedings of CHI 05. 2005.
- Oulasvirta, A., Petit, R., Raento, M., & Tiitta, S. (2007). Interpreting and acting on mobile awareness cues. Human-Computer Interaction, 22 (1&2), 97-135.
- Oulasvirta, A., Raento, M., and Tiitta, S. 2005. ContextContacts: re-designing SmartPhone's contact book to support mobile awareness and collaboration. In Proceedings of the 7th international Conference on Human Computer interaction with Mobile Devices &Amp; Services (Salzburg, Austria, September 19 - 22, 2005). MobileHCI '05, vol. 111. ACM, New York, NY, 167-174. DOI= http://doi.acm.org/10.1145/1085777.1085805
- Pascu, C., 2008. An Empirical Analysis of the Creation, Use and Adoption of Social Computing Applications, Office for Official Publications of the European Communities, ISBN 978-92-79-09453-8
- Rittenbruch, M., and McEwan, G., 2009, An Historical Reflection on Awareness in Collaboration, in Awareness systems, Springer, HCIS, ISBN: 978-1-84882-476-8
- Rowan, J. and Mynatt, E.D. (2005) Digital Family Portrait Field Trial: Support for Aging in Place. Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI 2005), 521-530.
- Romero, N., v. Baren, J., Markopoulos, P., de Ruyter, B. and IJsselsteijn, W.A. 2003. "Addressing Interpersonal Communication Needs through Ubiquitous Connectivity: Home and Away". In: Ambient Intelligence, EUSAI 2003, LNCS 2875, Springer, 419-430.

- Romero, N., Markopoulos, P., van Baren, J, de Ruyter, B., IJsselsteijn, W., Farshchian, B. (2007) Connecting the Family with Awareness Systems. Personal and Ubiquitous Computing, 11 (4), Springer, 299-312.
- Rowan, J. and Mynatt, E.D. (2005) Digital Family Portrait Field Trial: Support for Aging in Place. CHI '05, 521-530.
- Saslis-Lagoudakis, G., Cheverst, K., Dix, A., Fitton, D., and Rouncefield, M. 2006. Hermes@Home: supporting awareness and intimacy between distant family members. In Proceedings of the 18th Australia Conference on Computer-Human interaction: Design: Activities, Artefacts and Environments (Sydney, Australia, November 20 - 24, 2006). J. Kjeldskov and J. Paay, Eds. OZCHI '06, vol. 206. ACM, New York, NY, 23-30. DOI= http://doi.acm.org/10.1145/1228175.1228183
- Schmidt, K., 2002. The problem with 'awareness'. Computer Supported Cooperative Work vol. 11, 285–298.
- Sellen, A., Hyams, J., and Eardley, R., The Everyday Problems of Working Parents, Report HPL-2004-37, HP Labs, 2004.
- Sellen, A., Eardley, R., Izadi, S., and Harper, R. 2006. The whereabouts clock: early testing of a situated awareness device. In CHI '06 Extended Abstracts on Human Factors in Computing Systems (Montréal, Québec, Canada, April 22 - 27, 2006). CHI '06. ACM, New York, NY, 1307-1312. DOI= http://doi.acm.org/10.1145/1125451.1125694
- Smith, I., Consolvo, S., Lamarca, A., Hightower, J., Scott, J., Sohn, T., Hughes, J., lachello, G. and Abowd,
   G., Social Disclosure of Place: From Location Technology to Communication Practices, Lecture
   Notes in Computer Science, Volume 3468, 2005, Pages 134 151
- Sohn, T., Li, K. A., Griswold, W. G., and Hollan, J. D. 2008. A diary study of mobile information needs. CHI '08. ACM, 433-442.

Strauss, A.L., and Corbin, J. (1990) Basics of Qualitative Research, Cambridge University Press.

- Strong, R. & Gaver, B. Feather, Scent and Shaker: Supporting Simple Intimacy. Proc. CSCW'96, ACM (1996)
- Tang, J. C., Yankelovich, N., Begole, J., Van Kleek, M., Li, F., and Bhalodia, J. 2001. ConNexus to awarenex: extending awareness to mobile users. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (Seattle, Washington, United States). CHI '01. ACM, New York, NY, 221-228. DOI= http://doi.acm.org/10.1145/365024.365105

Techneos Systems Inc. http://www.techneos.com/ (last accessed: 21-02-09)

Tollmar, K. & Joakim, P. Understanding Remote Presence. Proc. NordiCHI (2002)

- van Veldhoven, E., Vastenburg, M., Keyson, D. (2008) Designing an Interactive Messaging and Reminder Display for Elderly. European Conference on Ambient Intelligence, Springer LNCS 5355
- Vetere, F., Gibbs, M., Kjeldskov, J., Howard, S., 'Floyd' Mueller, F., Pedell, S., Mecoles, K., Bunyan, M., Mediating intimacy: designing technologies to support strong-tie relationships, CHI 2005
- Voida, A., Voida, S., Greenberg, S., and He, H. A. 2008. Asymmetry in media spaces. In Proceedings of the ACM 2008 Conference on Computer Supported Cooperative Work (San Diego, CA, USA, November 08 - 12, 2008). CSCW '08. ACM, New York, NY, 313-322. DOI= http://doi.acm.org/10.1145/1460563.1460615

Weiser, M., (1992), The Computer for the Twenty-First Century, Scientific American, pp. 94-104

Weiser, M. and Brown, J. Designing calm technology. Powergrid Journal, v 1.01, July, 1996.

- Weiss, H. M., Beal, D. J., Lucy, S. L., & MacDermid, S. M. 2004. Constructing EMA studies with PMAT: The Purdue Momentary Assessment Tool user's manual. Retrieved from http://www.cfs.purdue.edu/MFRI/pages/PMAT/index.html (last accessed: 21-02-09)
- Wright, P. C. and Monk, A. F. 1991. The use of think-aloud evaluation methods in design. SIGCHI Bull. 23, 1 (Jan. 1991), 55-57. DOI= http://doi.acm.org/10.1145/122672.122685
- Yamine Evelyn, Caught out on Facebook but is this for real?, October 23, 2008, The Daily Telegraph, http://www.news.com.au/dailytelegraph/story/0,22049,24538993-5001021,00.html (last accessed on 30/12/08)
- Yarosh, S., Chew, Y.C., and Abowd, G.D. Supporting Parent–Child Communication in Divorced Families. International Journal of Human Computer Studies 67, 2 (2009), 192-203.
- Zuckerman, O, & Maes, P.: CASY: Awareness System for Children in Distributed Families. In Proc. IDC'05, Conference on Interaction Design and Children. Boulder, Colorado, New York, NY, ACM Press. 2005

### APPENDIX I: INTERLYSIS: A RESEARCHER'S TOOL FOR INTERVIEW DATA ANALYSIS

After the 20 interviews presented in Chapter 2 were completed, the audio recordings were fully transcribed in a file. Each and every statement was coded. The code followed the pattern: "<first letter of the researcher's name><number of interview>.<number of statement>". An example of a code is: "J7.91"; which means that it is the 91<sup>st</sup> statement of the second interview conducted by researcher: "Javed".

These files were afterwards printed. Then each set of question-statement was categorized. The categories emerged while reading again the transcriptions and trying to fit any question-statement set into a category. If that was not possible then a new category was created. Initially there were 7 categories with subcategories. These categories were:

- Communication during a day,
- Communication exceptions,
- Opinions,
- Interruptions,
- Communication with extended family,
- Activities,
- Communication mediums.

For each category we summarized the ideas emerging from the participants' statements. Those summaries were based in general statements that we could see being repeated in the original data. Very soon though we realized that it is very difficult for us the researchers:

- Handle the volume of paper produced,
- Collaborate on the already acquired material,
- Edit our comments,
- Present our results to third persons,
- Keep the connection of our statements to the original transcription.

For those reasons we decided to use a computer-assisted qualitative data analysis application (CAQDAS). The major drawback of a CAQDAS reported is "potential alienation between researchers and their data" (Kelle, 2004). A data analysis application that we already had in our disposal was Atlas.ti version 4.2 (http://www.atlasti.com/). Although quite extensive the main reasons that did not fit our purposes was the fact that it is a static desktop application. Since the method we used involved in parallel two researchers an online application was absolutely necessary to support collaboration

and progress tracking. A second reason was that it needed quite an effort to understand and use the interface.

#### **The Interlysis Application**

We soon realized the need of having an easy way to backtrack from our summaries to the participants' statements. That was the initial requirement. For that reason we created Interlysis. Interlysis is a database application with a web interface. It has stored all of our analysis connected with the participants' statements. While the development of Interlysis progressed, it became clear that it is much more than just "an easy way to backtrack from our summaries to the participants' statements". It is a collaborative tool that supports several researchers at the same time to keep a connection between their analysis and the actual collected data.

In our case, all the statements, which were already in electronic format, were inserted in a table in a relational database as separate records. Then while writing summaries of the observed data we had the ability to reference and therefore support our summaries with the transcriptions. An example of the produced document can be seen in the following image.

	View this document without references to participants comments   View the demographics   Vie Communication during a day	Main category title
Researcher's	What's the content of communication between parents Communication during the morning is more practical and evening & short term plans can can can can can be be not communicate a lot during the morning due to the fact more quiet in the morning can can can can can. Very little em-	in the morning? evolves around r, some couples do that husband is otional
based on participant's statements	Communication will take place du participant coment in 16 ft "goodbye-kiss". Is there communication while tr No mas ease mas team team. The reason needed while driving (in the case Reasons for communication dur Reasons for communication dur the set of the set of the set of the set means the set of the set of the set the set of the set of the set of the set the set of the set of the set of the set the set of the set of the set of the set of the set the set of the	attention that is
	Contenting the communication between the sector. If a new content of the sector of the	whom baby estation as. The main reason k and do not want of the participants  Participant's demographical data
	If communication is established, the reasons for communic - To inform about departure from office (0.30) (0.30) (0.30) (0.30) (0.30) (0.30) (0.30) - In case of change of plans, due to extra work, usually to late for dinner, usually it is the husband (0.30)	cating are: inform that will be

Image 1: Final analysis document

In the image the grey-shadowed text is the actual analysis that was inspired. The main category as well as the sub-category title can be seen followed by a paragraph which is explanatory to the sub-category. To be specific the sub-category seen in the image is describing our analysis on the topic of "communication of parents during the morning". The second statement of that is: "However, some couples do not communicate a lot during the morning due to the fact that husband is more quiet in the morning [J6.10] [J7.10] [J7.9] [J8.28] [J9.19]".

The square brackets include statements from the participants that support the declared statement. The participant's statement is seen only when the user of Interlysis is placing his mouse over the reference in the square bracket. In the example in the image we placed the mouse on top of reference [J7.9]. At that moment we can read the transcription record with code J7.9.

Interlysis was created by the following technologies:

- Server-side script language PHP
- Client-side script language JavaScript
- Database MySQL
- Researcher's editor environment: Phpmyadmin
- Webserver Apache

The application can be browsed online at the following address: http://www.awareness.id.tue.nl/interlysis/

#### Discussion

Although the application we described handles only textual data and it is in development phase, it has several advantages:

- It is online, therefore perfect for collaboration between researchers,
- directly connects researchers' conclusions with raw data,
- supports several views of the researchers' analysis,
- direct view of both analysis and raw data.

In future Interlysis could support the following features:

- Turn the interface to wiki-based so that other researchers have the ability not just to view the analysis but also edit it,
- improve the overall outlook of the application,
- support the conversion of transcription files to records of the database,
- for participant statements include the original part of the audio file,
- export researchers' analysis to several other formats (pdf, doc).

Interlysis is a supportive tool to researchers who are using interviews as their methodology. Its main goal is to eliminate potential alienation between the researchers and their collected data.

# **APPENDIX II**

Statements used (in the way when wished to be shared) in the online survey study

that I am a few minutes idle behind my computer

that I am logged out from my computer

that I am available for communication at home

that I am available only for urgent calls at the office

that I am away from my office

that I do not want to be disturbed now

that I am in a meeting

that I am working on something

that I am at home

that I am busy

about the general noise level of the room I am in

about what is going on in the room I currently am

that I am in my desk at the office

that I am engaged in an Instant Messaging conversation with another user

that I can be accessed by telephone right now

about how I am feeling today

that I slept well today

about how much exercise I had today

about how many times I spoke with other people today

about how long have I walked today

about the schedule I have for today

about when my next meeting is

about what the title of my next meeting is

about the traffic conditions near the location I am

about my Instant Messenger status

about the weather forecast of the region I am

about the news headlines I am reading

about a comic strip I saw

about when I am close to the supermarket

that I am close to a friend
about the location I currently am
about when I am driving the car/motorcycle/bicycle
about the medication I have taken during the day
about the meals I took today
about a few pages from a book I like
that I am wishing him/her a good day
about when I leave my workplace
that I left the children at school
about when I picked up the children from school
that my computer is on
that I am having a break

## Remarks:

- Statements do not reflect whether awareness information is implicit or explicit
- Only the related awareness information is noted and not the rest of the functionality offered by the prototypes presented
- Statements do not reflect whether the information is for the office or the home environment
- Statements do not reflect in what way the awareness information is presented
- Statements do not reflect the user groups involved

## LIST OF PUBLICATIONS

#### Journals

- Khan, V.J. and Markopoulos, P., (2009) Busy families' awareness needs, International Journal of Human-Computer Studies, Volume 67, Issue 2, Elsevier (2009), pp. 139-153
- Khan, V.J., Markopoulos, P., Eggen J.H. and Metaxas G., Evaluation of a pervasive awareness system designed for busy parents, Pervasive and mobile computing, Elsevier to appear

#### **Conference** papers

- Khan, V.J., Markopoulos, P., Eggen, B., (2009) An experience sampling study into awareness needs of busy families, Proc. HSI '09, IEEE pp. 338 343
- Khan, V.J., Markopoulos, P., Eggen, B., de Ruyter, B., IJsselsteijn, W.A., (2008) Reconexp: A way to reduce the data loss of the Experiencing Sampling Method. Proc. MobileHCI '08, ACM pp. 471-476
- Khan, V.J., Markopoulos, P., de Ruyter, B., IJsselsteijn, W.A., (2007) Expected Information Needs of Parents for Pervasive Awareness Systems. Proc. Ambient Intelligence 2007, LNCS, pp. 332-339
- Khan, V.J., Markopoulos, IJsselsteijn, W.A., (2007)Combining the Experience Sampling Method with the Day Reconstruction Method, Proceedings 11th CHI Nederland conference, pp. 41 – 43
- Khan, V.J., Markopoulos, P., Eggen, B., (2007) On the role of awareness systems for supporting parent involvement in young children's schooling, Proceedings HOIT 2007, Springer, pp. 91-101
- Khan, V.J., Markopoulos, P., Mota, S.A., de Ruyter, B., IJsselsteijn, W.A., de Ruyter, B., (2006) Intra-family communication needs; how can Awareness Systems provide support?, Proceedings IE06, Volume: 2, IEE pp. 89-94

#### Workshop and demonstration papers

- Khan, V.J., Markopoulos, P. and Eggen, J.H., (2009) Features for the future Experience Sampling Tool, Proc. MobileHCI '09, ACM
- Khan, V.J., Metaxas, G., Markopoulos, P., (2008) Pervasive Awareness, Proc. MobileHCI '08, ACM pp. 519-521
- Kray, C., Bo Larsen, L., Olivier, P., Biemans, M., van Bunningen, A., Fetter, M., Jay, T., Khan, V.J., Leitner, G., Mulder, I., Muller, J., Plotz, T., and Irene de Vallejo, L. (2008) Evaluating Ubiquitous Systems with Users (Workshop Summary), Constructing Ambient Intelligence, Springer pp. 63-74

# SUMMARY

### MEDIATED AWARENESS FOR INTRA-FAMILY COMMUNICATION

The research presented in this thesis has two objectives. The first objective is to investigate the current communication practices of family members to stay in touch with each other. Based on this investigation it elicits requirements for new pervasive communication systems, called awareness systems, which aim to support intra-family communication. The second objective is to develop those awareness systems based on the elicited requirements and evaluate them. In this thesis we focus on families who consist of working parents with dependent children living under the same roof. Awareness systems can be defined as a class of computer mediated communication systems that support individuals to maintain, with low effort, a peripheral awareness of each other's activities and whereabouts.

In the context of the research conducted, a variety of methods were used and several applications to conduct the research were developed. More specifically interviews, field studies of two prototypes, web surveys and an adapted version of the experience sampling study were used.

The research endeavor started off with an interview study with twenty Dutch parents. The results of the interview were followed up with an online survey study and a prototype evaluation. A follow-up modified experience sampling study (Reconexp) helped in placing the previous findings into context. The objective of Reconexp was to find out the communication needs of busy parents under context.

The two prototypes which were created, SchoolAware and FamilyAware embody the primary characteristics of awareness system according to the aforementioned definition. SchoolAware automatically communicated the presence of children in school as well as their schedule information to their parents. FamilyAware gathered multiple sources of awareness information such as place, calendar information, computer activity and automatically exchanged that information between busy parents. Moreover, it enabled parents to exchange messages and photos along with the automatically captured awareness information. This information was presented in mobile phones.

The contributions of this thesis are twofold. First the thesis presents the intra-family communication needs that would drive the adoption of awareness systems. Moreover the thesis presents the implications for the design of such systems. Second the thesis examines a modification of the experience sampling method (ESM), the experience sampling and reconstruction method (ESRM). Evidence is presented which indicate the potential of the ESRM when compared to the ESM.

## ΠΕΡΙΛΗΨΗ ΤΗΣ ΔΙΑΤΡΙΒΗΣ

Η έρευνα που παρουσιάζεται στη συγκεκριμένη διατριβή έχει δύο στόχους. Ο πρώτος είναι να διερευνήσει τις υπάρχουσες ανάγκες επικοινωνίας των μελών μιας οικογενείας με στόχο να παραμείνουν σε επαφή κατά τη διάρκεια μιας τυπικής μέρας τους. Βασιζόμενοι στην προαναφερθείσα διερεύνηση, παρουσιάζονται απαραίτητα χαρακτηριστικά τα οποία πρέπει να περιλαμβάνονται σε νέα συστήματα επίγνωσης (awareness systems). Ο σκοπός αυτών των συστημάτων είναι να διευκολύνουν την επικοινωνία μεταξύ των μελών μιας οικογένειας. Ο δεύτερος στόχος της έρευνας είναι να αναπτύξει συστήματα επίγνωσης βασίζοντας τα στην προηγηθείσα έρευνα καθώς και να αποτιμήσει την χρήση τους για τις ανάγκες επικοινωνίας μιας οικογένειας.

Αυτή η διατριβή εστιάζεται σε οικογένειες οι οποίες αποτελούνται από γονείς οι οποίοι εργάζονται, συζούν στο ίδιο σπίτι και έχουν μικρά σε ηλικία παιδιά. Τα συστήματα επίγνωσης ορίζονται ως μία κατηγορία συστημάτων επικοινωνίας μέσω υπολογιστή, τα οποία υποστηρίζουν ανθρώπους να διατηρούν, χωρίς ιδιαίτερη προσπάθεια, επίγνωση των δραστηριοτήτων και της τοποθεσίας άλλων ανθρώπων.

Στο πλαίσιο των μελετών που παρουσιάζονται στη διατριβή, μια ποικιλία από μεθόδους χρησιμοποιήθηκαν και αρκετές πρωτότυπες εφαρμογές για τη διεξαγωγή της έρευνας αναπτύχθηκαν. Ειδικότερα, συνεντεύξεις, ερωτηματολόγια , δύο πρωτότυπα συστήματα επίγνωσης και μια τροποποιημένη εκδοχή της μεθόδου δειγματοληψίας εμπειριών (experience sampling method - ESM) χρησιμοποιήθηκαν. Η πρώτη μελέτη ξεκίνησε διεξάγοντας συνεντεύξεις με είκοσι Ολλανδούς γονείς. Τα αποτελέσματα των συνεντεύξεων στη συνέχεια οδήγησαν σε μία διαδικτυακή δημοσκόπηση (online survey study) και στη αξιολόγηση ενός πρωτότυπου συστήματος επίγνωσης. Μια τροποποιημένη εκδοχή της μεθόδου δειγματοληψίας εμπειριών (Reconexp) χρησιμοποιήθηκε για να θέσει τα ευρήματα των προηγούμενων μελετών κάτω από το πρίσμα πραγματικών συνθηκών της ζωής των γονέων. Ο στόχος του αυτής ήταν να αποκαλύψει τις ανάγκες επικοινωνίας γονέων λαμβάνοντας υπόψη το πλαίσιο κάτω από το οποίο ζουν και εργάζονται.

Τα δύο πρωτότυπα που παρουσιάζονται στην διατριβή, το SchoolAware και το FamilyAware ενσαρκώνουν πρωτογενή χαρακτηριστικά των συστημάτων επίγνωσης, σύμφωνα με τον προαναφερθέντα ορισμό. Το SchoolAware επικοινωνούσε αυτόματα, την παρουσία παιδιών στο σχολείο καθώς και πληροφορίες για το καθημερινό πρόγραμμά τους στους γονείς τους. Το FamilyAware συγκέντρωνε πολλαπλές πηγές δεδομένων όπως η τοποθεσία, πληροφορίες ημερολογίου, δραστηριότητα στον υπολογιστή και αυτόματα αντάλλασε αυτά τα δεδομένα μεταξύ των δύο γονέων. Επιπλέον, επέτρεπε στους γονείς να ανταλλάσσουν μηνύματα και φωτογραφίες με το ίδιο σύστημα. Όλα αυτά τα δεδομένα προβάλλονταν σε μια εφαρμογή για κινητά τηλέφωνα.

Εν κατακλείδι, η πρώτη συμβολή της διατριβής είναι η παρουσίαση των αναγκών επικοινωνίας μίας οικογένειας που θα ωθήσουν στην υιοθέτηση των συστημάτων επίγνωσης και τις επιπτώσεις για το

σχεδιασμό των συστημάτων αυτών. Η δεύτερη συμβολή της διατριβής παρουσιάζει μια τροποποιημένη εκδοχή της μεθόδου δειγματοληψίας εμπειριών (ESRM) και τα στοιχεία τα οποία καταδεικνύουν τις δυνατότητές αυτής σε σχέση με την πρωτότυπη μέθοδο (ESM).

# **CURRICULUM VITAE**



Vassilis Javed Khan was born in Thessaloniki, Greece on 17<sup>th</sup> June 1976. After graduating from the Computer Engineering Department of University of Patras in Greece he worked as software engineering at the Computer Technology Institute (CTI) in Greece. His three year experience at CTI stimulated an interest in the field of human

computer interaction. This interest lead him to the Netherlands where he completed the User-System Interaction (USI) post-masters program at Eindhoven University of Technology. As part of the USI program he worked at Vodafone R&D in Maastricht, the Netherlands were he researched interface and interaction aspects that affect a user's trust in a system. For his PhD dissertation he researched the role of pervasive computing and more specifically awareness systems, in supporting intra-family communication at the Industrial Design department of Eindhoven University of Technology. The Experience Sampling Method, one of the methods applied during his doctoral research, was the inspiration for him to continue as a post-doctoral researcher at the same department. His current research objective is to make a tool for researchers to conduct Experience Sampling studies from the comfort of their desks. He has recently become a father and has co-founded KidzFrame.com.