Encountering SenseCam: Personal Recording Technologies in Everyday Life

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ABSTRACT

In this paper, we present a study of responses to the idea of being recorded by a ubicomp recording technology called SenseCam. This study focused on real-life situations in two North American and two European locations. We present the findings of this study and their implications, specifically how those who might be recorded perceive and react to SenseCam. We describe what system parameters, social processes, and policies are required to meet the needs of both the primary users and these secondary stakeholders and how being situated within a particular locale can influence responses. Our results indicate that people would tolerate potential incursions from SenseCam for particular purposes. Furthermore, they would typically prefer to be informed about and to consent to recording as well as to grant permission before any data is shared. These preferences, however, are unlikely to instigate a request for deletion or other action on their part. These results inform future design of recording technologies like SenseCam and provide a broader understanding of how ubicomp technologies might be taken up across different cultural and political regions.

Author Keywords

Paratyping, SenseCam, Experience Sampling, Privacy

ACM Classification Keywords

K.4.2 [Computers and Society]: Social Issues; K.8.m [Personal Computing]: Miscellaneous

General Terms

Human Factors

BACKGROUND AND INTRODUCTION

In the past decade, there has been a rapid proliferation of small, digital, ubiquitous recording technologies, including everything from camera-phones to sensor networks. At the same time, researchers have been examining how novel recording technologies can be used to support a variety of human needs. One such technology, SenseCam, is a wearable digital camera that automatically captures photographs through a wide-angle lens (see Figure 1) [13]. These pictures can be taken on a schedule or in response to sensed stimulus (*e.g.,* movement, sound, light).

Figure 1. (left) The SenseCam form factor used in this study; (right) Sample SenseCam image.

The original goal of the SenseCam project was to augment human memory through passive recording of images. Experiments were undertaken to ensure that the sensors would trigger the capture of an image at appropriate intervals (*e.g.*, when transitioning between rooms in a house) [11] and to uncover basic design requirements for the wearer of SenseCam [13]. The current design is approximately the size of a deck of playing cards with battery life and storage capacity of a day. To address concerns about privacy and control of data, SenseCam developers explicitly excluded recording audio. Additionally, a simple button allows pausing of the recording of images.

SenseCam research generally has been focused on the needs of the primary user of SenseCam and its potential applications. Researchers have conducted numerous studies of SenseCam for use with patients with memory impairment (*e.g.,* [13, 20]), in educational settings [3], in business negotiations with blind users [22], and more. During previous studies of SenseCam, however, an interesting phenomenon was observed repeatedly: most of the people with whom the wearer interacted either did not notice the device or noticed it but comprehended neither its capabilities nor uses. Therefore, the extensive work in designing and evaluating SenseCam

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left open some fundamental questions about the experience of the people being recorded, such as those uncovered by Friedman *et al.* surrounding recording in a public plaza [10].

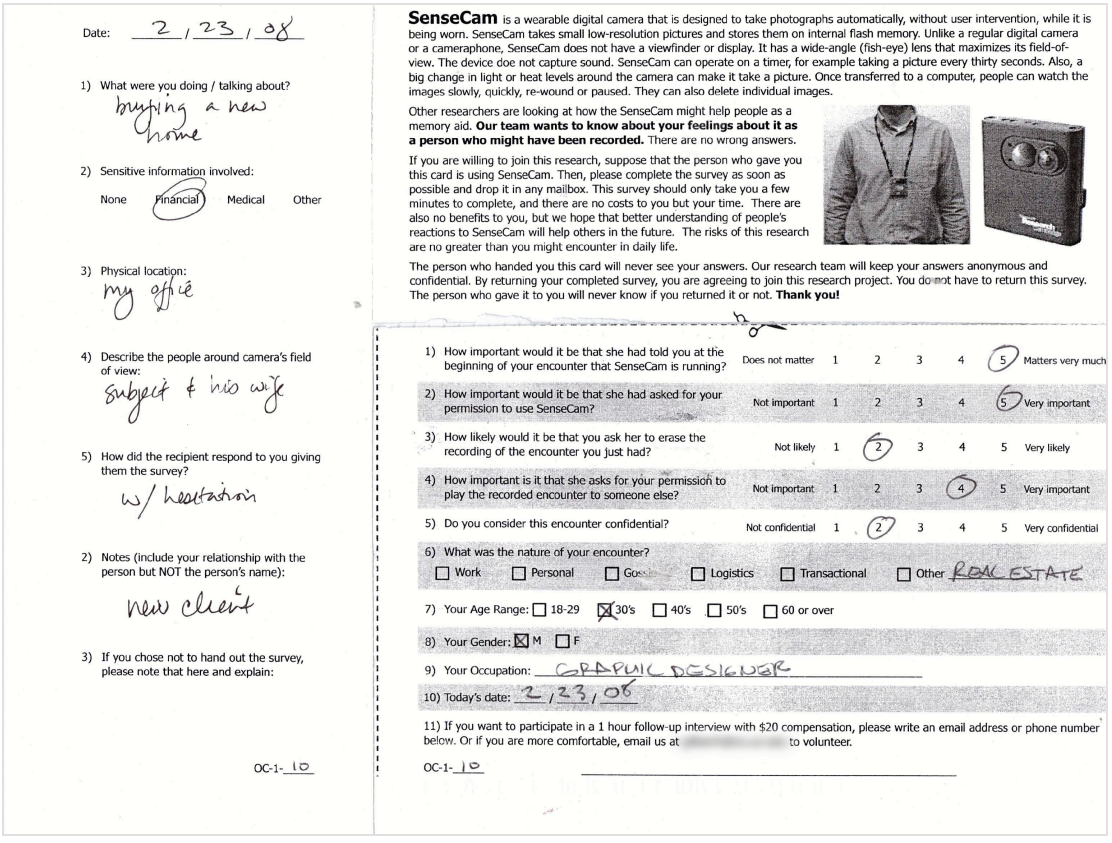
Assistive technologies like SenseCam, that have the power both to help people in need and to intrude on the autonomy and preferences of an individual user, require complex design and evaluation methods to appropriately balance the human values at work [9]. Thus, we set out to develop a broad but deeply contextualized understanding of everyday encounters with potential uses of SenseCam, in a variety of situations by a variety of individuals in four geographic locations. We used a situated method of inquiry to address five fundamental questions:

1. *To what degree* might secondary stakeholders, those being recorded, *accept or object* to the use of a device that can potentially make possible the rapid, repeated, and non-obvious recording of still images?
2. *What system parameters* (*e.g.*, ability to share images, form factor of the device) can be adjusted to meet a compromise between the interests of the primary users and those who could be recorded by SenseCam?
3. *What social processes and policies* (*e.g.*, demonstration of need, regulation of use) can be applied to meet this compromise?
4. *How do particular situations* impact perceptions and reactions?
5. *What,* if any, *cross-cultural differences* exist in responses to SenseCam in North American and European locations?

In this paper, we describe the underlying processes through which responses are constructed, indicating open challenges for the design and use of recording technologies. We also describe how system parameters, social processes, and policies can be adjusted to balance the needs of all stakeholders. We postpone the discussion of the related work until after these results so as to situate the discussion of the implications of this work within the related literature.

METHOD

This work includes a combination of an event-contingent experience sampling procedure called paratyping [15] and in-depth interviews. A paratype is "a simulation of interaction with a technology, which is evaluated alongside real-world experiences" [15]. This approach was used previously to evaluate a mobile audio recording application, the Personal Audio Loop (PAL) [1, 15]. In that study, as in this work, a variety of individuals acted as *proxies* for users of the technology being studied, creating the *experiences with the technology on which feedback was desired*.


Date: 2/23/08

1) What were you doing / talking about?
buying a new home

2) Sensitive information involved:
None Financial Medical Other

3) Physical location:
my office

4) Describe the people around camera's field of view:
subject & his wife

5) How did the recipient respond to you giving them the survey?
w/ hesitation

2) Notes (include your relationship with the person but NOT the person's name):
new client

3) If you chose not to hand out the survey, please note that here and explain:

OC-1-10

SenseCam is a wearable digital camera that is designed to take photographs automatically, without user intervention, while it is being worn. SenseCam takes small low-resolution pictures and stores them on internal flash memory. Unlike a regular digital camera or a cameraphone, SenseCam does not have a viewfinder or display. It has a wide-angle (fish-eye) lens that maximizes its field-of-view. The device doe not capture sound. SenseCam can operate on a timer, for example taking a picture every thirty seconds. Also, a big change in light or heat levels around the camera can make it take a picture. Once transferred to a computer, people can watch the images slowly, quickly, re-wound or paused. They can also delete individual images.

Other researchers are looking at how the SenseCam might help people as a memory aid. **Our team wants to know about your feelings about it as a person who might have been recorded.** There are no wrong answers.

If you are willing to join this research, suppose that the person who gave you this card is using SenseCam. Then, please complete the survey as soon as possible and drop it in any mailbox. This survey should only take you a few minutes to complete, and there are no costs to you but your time. There are also no benefits to you, but we hope that better understanding of people's reactions to SenseCam will help others in the future. The risks of this research are no greater than you might encounter in daily life.

The person who handed you this card will never see your answers. Our research team will keep your answers anonymous and confidential. By returning your completed survey, you are agreeing to join this research project. You do not have to return this survey. The person who gave it to you will never know if you returned it or not. **Thank you!**

1) How important would it be that she had told you at the beginning of your encounter that SenseCam is running? Does not matter 1 2 3 4 5 Matters very much

2) How important would it be that she had asked for your permission to use SenseCam? Not important 1 2 3 4 5 Very important

3) How likely would it be that you ask her to erase the recording of the encounter you just had? Not likely 1 2 3 4 5 Very likely

4) How important is it that she asks for your permission to play the recorded encounter to someone else? Not important 1 2 3 4 5 Very important

5) Do you consider this encounter confidential? Not confidential 1 2 3 4 5 Very confidential

6) What was the nature of your encounter?
☐ Work ☐ Personal ☐ Gossip ☐ Logistics ☐ Transactional ☐ Other REAL ESTATE

7) Your Age Range: ☐ 18-29 ☒ 30's ☐ 40's ☐ 50's ☐ 60 or over

8) Your Gender: ☒ M ☐ F

9) Your Occupation: GRAPHIC DESIGNER

10) Today's date: 2/23/08

11) If you want to participate in a 1 hour follow-up interview with $20 compensation, please write an email address or phone number below. Or if you are more comfortable, email us at [redacted] to volunteer.

OC-1-10

Figure 2. The survey form is divided in two parts linked by a unique ID, here shown after being reassembled. The left side is filled out by the proxy. The right side is given to the participant to examine privately. The upper portion is retained by the recipient and contains a description of SenseCam on the front and sample images on the back. The lower portion is returned to the researchers via the postal system and includes the survey on the front and the address of the researchers and a stamp on the back to form a postcard.

Paratyping was originally introduced as a form of Experience Prototyping [5]. As noted in that work, the primary difference between Buchenau and Suri's method of evaluating new products, in that case a more traditional digital camera, is the situated nature of the paratyping method. With this procedure, researchers can situate participant responses in a recent experience with a particular person in a particular location. Rather than reconstructing and role-playing interactions, paratyping puts the technology and a survey about it *in situ* by asking secondary stakeholders to complete a survey about their experiences in the moment. This setup is designed to reduce recall errors and decontextualized responses, without requiring potentially problematic encounters with actual SenseCam wearers. Likewise, experience sampling focuses on situating the user in the moment of inquiry and has been used successfully to evaluate ubicomp systems [7]. Paratyping, however, allows us to focus on secondary stakeholders, whereas experience sampling and other means of inquiry (*e.g.,* traditional diary studies) tend to be more focused on the primary user.

Proxies were recruited via mailing lists, online classified sites (*e.g.,* Craigslist, Facebook, Gumtree), and word of mouth. In all, 19 people acted as proxies for users of SenseCam over a period of two to four weeks each, distributing nearly 700 surveys in total. This research was conducted all within the same year in Toronto, Ontario, Canada (CAN, 3 proxies), Orange County, California, USA (US, 5 proxies), Cambridge, England (UK, 6 proxies), and Zurich, Switzerland (CH, 5 proxies). The proxies included 7 men and 12 women, aged 18 to early 60s with a variety of professions (*e.g.,* security guard, architect, caterer, student).

Each proxy participated in one hour of training prior to beginning the study. During this session, the researchers explained the purpose of the study, and described SenseCam by demonstrating its use and showing a video of sample output. Also during this training session, the paratyping method and procedure of distributing surveys were explained.

Survey Instrument and Distribution

As they went about their daily activities, at the end of every verbal interaction with an adult lasting longer than one minute, the proxies administered a survey using a procedure designed to maintain consistency among all proxies. The proxies first described SenseCam and the research by following a short pre-defined script. They then handed the participants written information about the study (see Figure 2, top right) attached to an anonymous survey form (see Figure 2, bottom right) to be completed privately. The proxies completed short questionnaires about the encounters (see Figure 2, left), also in private. Additionally, the opposite side (not shown) showed sample photos taken by SenseCam.

The portion completed by the proxies included a variety of questions describing the situation (*e.g.*, location, activity) and how the recipient responded to being handed a survey. The portion given to the participants asked them to suppose the proxy was using SenseCam and included questions about use of the device in *that specific encounter*.

To avoid respondent bias, proxies only distributed a survey to any individual once over the whole study, the first time they interacted with them for more than a minute. The one-minute threshold was chosen because the default SenseCam configuration involves images being captured every 30 seconds. The one-minute threshold is simple to remember and ensures that at least one picture would have been taken.

In consideration of safety and ethical concerns, in extreme cases determined by their own judgment, proxies could choose not to deliver a survey for a qualifying encounter. In such cases, the proxies noted a short reason for not distributing the survey. In practice, this situation only occurred 40 times across all four countries (6% of eligible interactions). Reported reasons for not distributing a survey included that the other person was in a hurry and could not accept the survey, the proxy was involved in an inappropriate social situation for survey distribution (*e.g.,* on a first date), or simply that the conversation partner was not interested in filling out a survey and refused to accept it. These instances, though minimal, were interesting as well, in that they are indicative of situations in which explaining and/or using SenseCam might also be inappropriate. As such, they were included in our analysis.

There are a myriad of reasons someone might want to use SenseCam in addition to the original intention of memory augmentation, as mentioned in the Introduction. Thus, in this work, rather than focus on SenseCam for any one purpose, survey recipients were asked to react to the specific person handing them the survey in the current situation. Of course, the original goal of memory augmentation or other presupposed uses could influence responses regardless of the instructions on the survey itself. To overcome this potential limitation, we specifically probed survey respondents during in-depth follow-up interviews to express any differences in their attitudes towards someone wearing SenseCam for purposes other than those they might have initially inferred, as described in the Results section.

Proxies were compensated approximately one to two USD in local currency for each survey up to 50 distributed regardless of return rate. Each proxy was provided with 55 surveys; the extra five surveys were for backup purposes. Proxies were expected to distribute at least half of the provided surveys. At the end of each week of the study, each proxy participated in an interview to ensure adherence to the protocol. Additionally, they were compensated for their time and travel for these weekly meetings.

Follow-up Interviews

Individuals who received a survey from a proxy and returned it with contact information were invited to participate in a follow-up interview. Fifteen people aged from in their 20s to in their 60s participated in these interviews (9 women), typically lasting an hour. All of the interviews were recorded and transcribed. Data from the first five proxies were

analyzed in depth by two of the researchers to identify emergent salient themes. The coding scheme was discussed amongst the research team and refined. Once the coding scheme was finalized and the inter-rater reliability was confirmed to be substantial (Cohen's Kappa > 0.61) [6, 16], the two individual researchers coded the remaining data and shared the coded transcripts with the rest of the team.

Presence of SenseCam

None of the proxies wore a fully functioning SenseCam during the study due to ethical reasons and to avoid the discomfort of those who may have privacy concerns with the technology. In the PAL study in which paratyping was first used as a method for eliciting contextualized responses, proxies carried devices with them for demonstrations by request from the survey recipient [15]. In this work, we were interested to learn whether such a prop, even a non-functional one, would influence responses. Thus, nine proxies carried non-functional SenseCams with them, and the others simply used the description on the survey for explanation. There were no meaningful differences in the survey data between proxies who carried SenseCams and those who did not. Furthermore, data from the follow-up interviews indicates that these artifacts were not influential.

RESULTS

We received 413 responses from 686 eligible encounters. The survey was not returned in 233 instances and not distributed in 40 encounters making a 64% response rate. Respondents ranged across professions, including: teachers, actors, designers, attorneys, realtors, receptionists, engineers, managers, restaurant staff, entertainers, and more. Of 413 respondents (205 female, 205 male, 3 undisclosed), 206 were under 30; 87 in their 30s, 60 in their 40s, 31 in their 50s, and 25 were 60 or older. Four participants did not provide age.

Our results indicate that individuals across all four countries involved in this study engaged in complex – though often rapid – reasoning and decision-making about SenseCam. People assessed, understood, and responded to SenseCam by drawing from their own personal values and beliefs, institutional and societal norms and customs, and their understanding of the technological features of SenseCam. Price *et al.* described four layers of "privacy protection" for users in ubicomp environments: their personal privacy policies, their regulatory regimes, the types of ubicomp service or technology, and the types of data being collected [19]. Although their work focused on ubicomp services in smart environments rather than on wearable recording technologies, our analysis revealed a compatible model of personal values, institutional and societal rules, technological features, and cultural influences.

In this section, we describe how our results answer the five research questions outlined in the Introduction by examining general acceptance of SenseCam, influence of system parameters and technological features, impact of current and potential social processes and policies, the contextualized nature of responses, and the cross-cultural differences among the four locations in this study. When little or no differences were observed, we describe the results across all sites together. In those situations in which we observed differences, we describe the results from the different countries independently.

Acceptance of SenseCam

Participants were generally accepting of SenseCam, in particular in consideration of a "valid" purpose. However, their concerns tended to increase when considering invalid or inappropriate uses. An understanding of and regulation based on these uses require being informed and potentially being able to consent or object to recording.

In considering their responses, individuals were concerned with protecting themselves – their images and identities – as well as with protecting and supporting others. Thus, they often made deeply personal decisions based on their individual values around disabilities.

> US2-5[1]: *...if this really helps people with Alzheimer's or amnesia or some kind of memory impairment, then that is really awesome. Go SenseCam!*

At the same time, people brought past experiences with cameras and their uses to bear on their considerations of why one might use SenseCam to capture images. These experiences were often in conflict and would require further explanation to reconcile. For example:

> CAN4-41: *if they explained… it's for a memory issue then I'd say "oh, fine" … if I didn't get a chance to ask them, then I might be a little weirded out still because I wouldn't automatically say "Oh well, they're probably using it to augment their memory or something."*

In many cases, these concerns could be addressed if the individuals being recorded could learn the purpose of the recording. However, SenseCam's potential status as an assistive technology could hinder questions about its use:

> UK1-43: *...since it's a sort of medical condition…I would still feel awkward to ask about it in detail, because maybe people don't want to talk about it.*

The preferences and means for notification, however, differed across the countries. Canadian, Swiss, and British respondents tended to report feeling more strongly about wanting to be notified (CAN $\mu = 3.62$, $\sigma = 1.43$; CH $\mu = 3.70$, $\sigma = 1.48$; UK $\mu = 3.35$, $\sigma = 1.44$) than their counterparts in the US ($\mu = 2.82$, $\sigma = 1.37$) (respectively, Pearson $\chi^2(4) = 22.08$, $p < 0.001$; Pearson $\chi^2(4) = 22.00$, $p < 0.001$; and Pearson $\chi^2(4) = 11.16$, $p < 0.05$), where 1 is "not important" and 5 is "very important." Furthermore, fewer US participants indicated wanting to be notified (40, 34%) than not (48, 41%) with a substantial section of US respondents (30, 25%) being neutral ($\mu = 2.82$, $\sigma = 1.37$) (see Figure 3).

[1] Participant quotes are labeled by code: geography first, followed by proxy number, and the final number is the code for the individual who returned the survey.

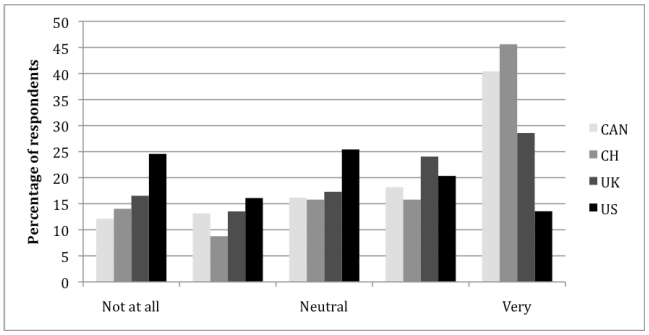


Figure 3: Importance of Being Told about SenseCam

Additionally, the results demonstrate a slight preference in three out of the four countries (CAN, CH, and UK) for the SenseCam user to ask for permission before using the device: 200 (60%) indicated a 4 or 5 (CAN μ= 3.61, σ = 1.45; CH μ= 3.75, σ = 1.41; UK μ= 3.34, σ = 1.35) (see Figure 4). In the US population, however, only 41 participants (35%) indicated a 4 or 5 versus 49 participants (42%) who responded 1 or 2, with μ = 2.86, σ 1.39 (respectively, Pearson $\chi^2(4) = 26.47$, $p < 0.001$; Pearson $\chi^2(4) = 18.57$, $p < 0.005$; and Pearson $\chi^2(4) = 14.30$, $p < 0.01$). The preference for permission by more than a third of respondents in every country indicates an open challenge for obtaining that permission from every person who potentially could be recorded by SenseCam.

The general preference for informed consent across the majority of the participants in the majority of the countries can be explained by further examining how people constructed concerns about protecting themselves and others. For example, one respondent articulated concerns about ensuring that his children would be protected, that images of them would not be made publicly accessible on the Internet, and so on. Many people questioned how they might manage impressions about themselves, either because an unattractive image may be portrayed or they may be recorded doing something legally or socially problematic.

> UK2-3: *I wouldn't mind being recorded but of course, I would react or behave in a more appropriate way, because I know I'm being recorded… I would be, I don't know, more serious.*

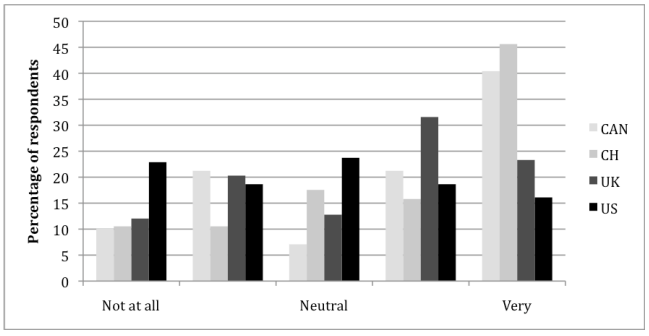


Figure 4: Importance of Being Asked Permission Before Use

Often, this view was expressed in the negative, as well:

> UK2-5: *…if I was a more suspicious character, it'd probably be a different answer.*

As noted in the cultural differences section, participants in all of the geographies were concerned about impression management. In the US, this concern primarily manifested in considerations of attractiveness, whereas in the other countries, this concern primarily manifested in concerns about behavior, such as in the preceding two examples.

System Parameters, Features, and Design

Both technophiles and relative technological "newbies" brought to bear assumptions and direct explanations about what SenseCam could and could not do when considering and responding to it. These technological considerations centered on a variety of issues, including the quality and bandwidth of the recorded media, the functionality of the device, its aesthetics, and tensions between usability, visibility, and feedback.

In terms of image quality, people generally perceived SenseCam to provide good enough recording to "jog" memories without being such high quality as to present a significant threat. These responses were grounded in sample images they were shown during interviews and in images provided with the surveys. Furthermore, the vast majority of participants commented on being more comfortable with SenseCam knowing it did not include audio.

> CAN4-41: *…there's also the audio aspect to that and it's a bit more invasive. …[SenseCam is] not taking too much information, it's just sorta' like what he's seeing, right? And he's not going to be able to go and review what everyone said. So I think it will make a difference.*

> UK2-5: *I would be bothered more about having my voice recorded…picture taken, I don't really mind…*

More traditional cameras were viewed quite differently from SenseCam. In some cases, the differences made SenseCam more comfortable. In particular, the absence of traditional framing of the photograph may change the requirements for the image held within the photograph to be stylized and attractive. For example, one participant described a situation in which she was feeling unattractive:

> US1-21: *If she had the camera on and it's hanging on her chest I wouldn't mind versus getting a professional camera and taking a picture. A camera on the chest is okay. It's not professional. … That wouldn't bother me, but if someone wants to take a picture, just out off the bat like that, a different picture with a regular camera, then I wouldn't appreciate that.*

This casualness of the documentation of the moment alleviated some pressures inherent to high resolution, intentional photography. At the same time, SenseCam's frequent automatic recording creates its own concerns, often with regard to the lack of preparation by the image subjects and the sheer volume of images created:

UK2-3: *The difference between her taking out a camera and … smiling to a camera, as opposed to a camera that is automatically taking pictures of you. It's just too many pictures in a way.*

In addition to functionality, people reported a link between the outward appearance of SenseCam and their responses to it. Although most people preferred that it be "less bulky" and aesthetically pleasing, they also noted the tension between this sort of design and the invisibility it might imply. Some individuals even associated intentionality to the specific design of the prototype device:

UK2-5: *That's probably why the SenseCam is designed to be so conspicuous, and very clearly worn on the front of someone's chest so that it is visible and people know what's going on.*

Visibility of the device and feedback about its recording are likely to continue to be important cues in helping people to respond to new ubicomp technologies.

Social and Institutional Processes and Policies

Our results indicate that wanting to be informed and to consent may not translate into being willing and able to take action to enforce those preferences, even during possible confidential or sensitive encounters. In particular, people often feel incapable of requesting deletion or objecting to the sharing of data in light of interpersonal relationships. Thus, in the future, people may rely on institutional policies and protections rather than existing social relationships.

During interviews, people described feeling that it would be inappropriate to intrude on the wishes or needs of a SenseCam user, in particular one with a disability, to satisfy a desire for deletion. Furthermore, the discomfort of the existence of an image one wants deleted may simply not be worth the discomfort of disrupting a social relationship through the request for deletion. The majority of participants answered that they would be unlikely to ask someone to delete an image (91 (77%) US, 57 (59%) CAN, 94 (71%) UK, 29 (51%) CH; $\mu = 2.23$, $\sigma = 1.39$, where 1 is "not likely" to request deletion and 5 is "very likely") (see Figure 5). This discomfort goes the other direction as well, with potential users of SenseCam also not wanting confrontations. For example, one proxy commented during his weekly visit:

CH2: I really don't want to provoke anybody. I'd absolutely want to avoid a fight about [wearing SenseCam].

By contrast, a much larger concern for most people – one that might be worth the confrontation to address – was a consideration of who might have access to their images and how. In the majority of sites studied in this work, people stated it was important or very important that the SenseCam user ask permission before sharing captured data with others (24 (59%) CAN, 46 (53%) UK, 10 (64%) CH). In the US population, people were roughly split on whether it was important that the SenseCam user ask permission before sharing captured data with others: 44 out of 118 participants

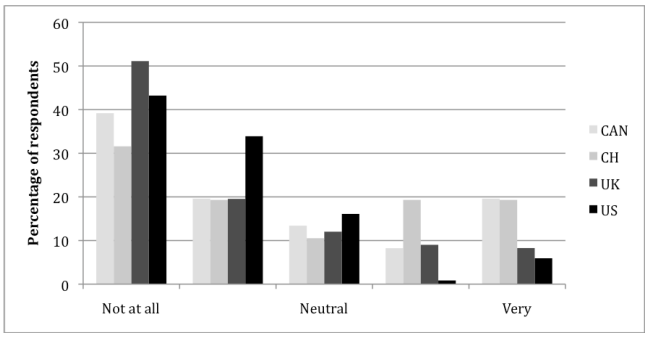


Figure 5: Likelihood of Requesting Deletion

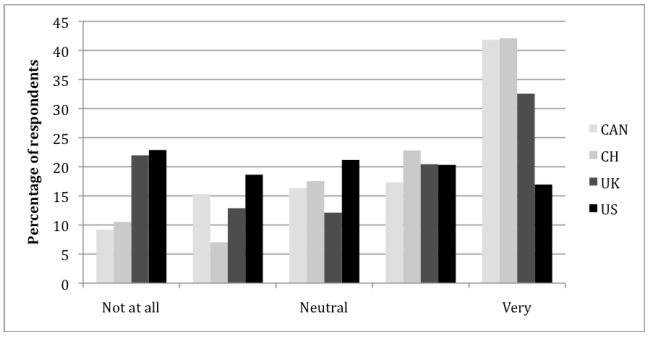


Figure 6: Importance of Being Asked Permission Before Sharing

(37%) answered a 4 or 5, with $\mu = 2.90$, $\sigma = 1.41$, where 1 is "not important" and 5 is "very important." 25 (21%) of respondents answered neutrally with a 3. And the rest (49, 42%) answered 1 or 2 (see Figure 6).

Across all four sites, people described "social contracts" (UK3-6) that enable trust and comfort with someone recording. These agreements and relationships may enable people to trust users with any pictures for "personal" or "individual" use but not for sharing.

UK1-43: *Someone who is using this device would destroy the whole trust and personal relationship with the person if it turns out that this person is showing these pictures to someone else.*

Likewise, people generally agreed that anyone who experienced the encounter "live" – not just the SenseCam user – should be able to access a recording of it later for "personal" use. Similarly, participants were generally comfortable with the idea that users might share the recordings with a therapist or close friend or family member. For some people, however, the idea that SenseCam images *could be* shared even if it was unlikely they *would be* shared resulted in a desire for the images to be deleted in highly sensitive cases. For example, one participant described such concerns about changing clothes in front of a proxy:

UK2-3: *If there was a possible way for her to show that to somebody else, then I would ask her to erase it.*

Despite expressing a preference for granting permission to share SenseCam images (and in some cases even to record them in the first place), participants often recognized the

futility of a desire not to be recorded in terms of their own abilities to effect change surrounding image capture in daily life. For example, participants described becoming habituated to CCTV due to its fundamental inescapability. This metaphor served them in their descriptions of a future world proliferated by SenseCams. Similarly, participant experiences of spending huge amounts of time trawling sites such as Facebook and Flickr to find (and sometimes to request removal of) pictures from social outings influenced their views about the accessibility and personal control of their own image on-line. Finally, they also described feeling limited in what they could ask of a stranger, a boss, a colleague, or even a friend or family member.

The limited ability of the individual to effect change indicates the potential for greater reliance on larger institutions. Institutional policies, cultural and societal norms, and even laws surrounding SenseCam and other recording technologies can handle some of the adjudication work required to balance stakeholder needs in both the short and long terms. Thus, interpretations of the rules of a variety of structural institutions inherent to the particular encounter queried in the survey – families, countries, corporations, and so on – greatly impacted the way SenseCam was construed.

In addition to drawing on existing social systems to help interpret potential encounters with SenseCam, participants often suggested institutional interventions to help govern the appropriate use of SenseCam and other recording technologies. Notably, comments that indicated comfort with use of SenseCam nearly all included the notion that the device would be "issued" or "prescribed" to users who need it as opposed to purchased off the shelf by anyone.

> UK3-6: *I don't know how [SenseCams] will be issued, but I think it would need to be for legitimate reasons… I hadn't really thought about it being … an off the shelf product. … if it were an off-the-shelf product, then there would probably be times or situations where I would say no.*

Hand in hand with notions of governing or prescribing SenseCam were considerations of how to delineate what it is and what it does. Current institutional metaphors were expanded from the process and policies for deploying the device into the process for designing it:

> US1-21: *I think that maybe they should put like a little handicap sign, like the little chair or maybe there should be a universal handicap sign for mental [sic]… There has to be some kind of sign that is universal.*

Suggested regulations on design did not stop with notification, labeling, and branding of the device. Participants also noted the tension between being able to hide the device to make it more amenable to everyday use and the ability for those who might be recorded to perceive it. Thus, many individuals suggested governance around the hardware design to ensure an appropriate compromise.

Contextual Responses

As expected, different situations often warranted different responses to use of SenseCam. In particular, in this work, we were interested in whether participant contextualization of situations that are likely to be "private" by some definition of the word would be indicative of the appropriateness of SenseCam. Thus, the surveys asked both proxies and survey recipients to provide a measure of the sensitivity or confidentiality of their activities. The survey recipients rated subjective *confidentiality* on a five-option Likert scale. Proxies indicated whether the conversations were *sensitive* using particular legal categories of sensitivity: financial, health, or other. A limited number of responses were indicated to be sensitive (n = 152, 22%), with only 40 (6%) being reported as including financially sensitive information, 30 (4%) including medically sensitive information, and 87 (13%) reporting otherwise sensitive information. Some situations were demarked as being sensitive in more than one way, thus making the sum of these individual categories higher than the overall category. In 530 situations, proxies reported no sensitive information at all. In four situations, the proxy did not answer this question. There was almost no correlation between reported sensitivity from the proxies and reported confidentiality from the survey recipients (rho = -0.13, $p < 0.01$), indicating that two people engaged in a conversation may not be able to come to consensus to judge the confidentiality of the situation consistently to make appropriate choices.[2]

There were no statistically significant pair-wise differences between countries with regard to confidentiality and sensitivity. Thus, we report these results collectively in this section. Across all four countries, participant wishes to be notified did not vary based on the sensitivity of the topic as classified by the proxy (rho = -0.10, $p < 0.05$) nor the confidentiality as classified by the participants themselves (rho = 0.27; $p < 0.001$). The responses to asking permission before use did not vary based on the sensitivity of the encounter as rated by the proxy (rho = -0.11, $p < 0.05$) nor the perceived confidentiality and this variable (rho = 0.32, $p < 0.001$). There was a weak correlation between preferences around being asked permission to share the data and confidentiality (rho = 0.44; $p < 0.001$) and no correlation between this variable and sensitivity (rho = -0.03; $p < 0.57$). These results suggest that there is particular concern with what happens to image data based on the perceived confidentially as assessed by the individual being recorded. However, the SenseCam user – even when trained in recognizing legally sensitive situations, as was the case with these proxies – may not recognize those moments.

While it might seem appealing to automatically determine the contexts in which SenseCam should or should not be used, the factors that determine the choice are inherently

[2] Spearman's *rho* was used to calculate correlation due to the non-parametric nature of Likert scale data.

	Notify	Consent
Consent	*rho* = 0.759, $p < 0.001$	
Share	*rho* = 0.647, $p < 0.001$	*rho* = 0.718, $p < 0.001$

Table 1: Correlations at Southern California site between notification, consent to use, and permission to share responses.

unavailable to computational systems. Instead, any particular interaction includes rich, compound contextual information. For example, rather than being able to determine *a priori* that recording is not acceptable in certain situations, as with CCTV in the home [17] or web cameras in a shared semi-public workspace [12], responses to SenseCam are much more nuanced in their relation to the people, activities, and locations involved. For example, one participant in the U.S. described herself as "vain" and commented repeatedly that she would want to ensure she was attractive in any and all pictures. However, she somewhat surprisingly described being comfortable with unattractive pictures being taken in a narrow subset of situations, such as being at home due to her chronic illness.

> US1-21: *...let's say that I'm not feeling well and I have a lot of pain…. So then if someone cares about me, they're going to come visit me ... and that person could be using that camera and I'm okay because they care about me ….*

Sensing automatically that this situation was acceptable is nearly impossible. Thus, it is a substantial open challenge to design technologies and policies surrounding them that can adapt to the varying contexts in which they might be used.

Cross-Cultural Differences

Cross-cultural differences emerged in the survey and interview data between the four countries involved in this study. For example, British perceptions about CCTV in relation to SenseCam were more profound than in other geographies. Likewise, American perceptions about the "body beautiful" in relation to SenseCam brought notions of aesthetics, attractiveness, and impression management more to the forefront of considerations than in other nations [21].

Across the primary survey questions (Questions 1-4, Figure 2), the US participants answered significantly differently from the other three countries. During pair-wise comparisons with the US data for each of those questions, chi-square values were between 10.51 and 30.73 with all $p < 0.05$. By contrast, the remaining pair-wise comparisons (*i.e.*, Canada and UK, Canada and Switzerland, UK and Switzerland) resulted in chi-square values between 1.05 and 13.23 all with all but one $p > 0.05$. Even within sites that look quantitatively similar, however, differences emerged in the qualitative responses.

Exposure to particular technological and cultural practices surrounding the capture and sharing of images influenced participant reactions to SenseCam. In particular, participants in all four sites commented about the pervasive nature of recording technologies like CCTV and sharing technologies like Flickr and Facebook. However, participants in the UK described their experiences as specific to their country.

> UK1-43: *I think when I'm in public, especially in Britain, I expect to be recorded anywhere all the time.*

> UK2-5: *...living in England for several months has kind of desensitized me… I'm being filmed all the time no matter where I go.*

Regardless of whether or not participants in the UK were accurate in stating that they are recorded by CCTV at all times or even whether this way of life is unique to the UK, these results are interesting for what they tell us about the general perceptions of behavior in public life, power, and control of recording by the government in that country. British participants were acutely aware of the influence of these policies on their lives, and as such, they tended to describe the impact of information and privacy laws more often than participants in other countries.

> *UK3-6: ...for the Data Protection Act as it works in this country, it wouldn't be viable to use [SenseCam recordings] in any court situation.*

American participants responded markedly differently to concerns about impression management than those in the other geographies. Americans were consistently more concerned with how they physically appeared in pictures than with what they were doing or who else was with them in images. In the US, particularly in Southern California, the "body beautiful" ideal may have influenced the ways individuals respond to recording. Despite some basic similarities in the history and ideals of beauty across many Western countries, Americans have typically been alone in tying beauty tightly to good moral character. In other nations, being overweight or unattractive is not a positive feature, but it is also not a sign of moral weakness [21]. The American striving to be attractive faces the fear of social disgrace and moral failure, whereas other Westerners in the same situation can focus on being attractive without a "personal demon to exorcise" [21, p. 210]. These cultural divergences may help explain why the US was the only site in which strong correlations in the survey responses were observed between wanting to be notified, wanting to consent, and wanting to be asked for permission before sharing (see Table 1). These results indicate space for future work in teasing apart the specific considerations around visual image in this location.

DISCUSSION

Understanding and responding to ubicomp recording technologies is highly contextualized and personal, necessitating a situated inquiry method like paratyping to reveal the complexity and nuance of these decision-making processes. Furthermore, regardless of how participants reported feeling about wanting to know about being recorded, they nearly never reported being willing or able to take action to change that situation. Thus, obtaining informed consent for recording, retaining, and sharing images is an

open challenge in the design and creation of new ubicomp recording technologies.

SenseCam provides a particularly interesting example of recording technologies when considering truly *informing* – and not just notifying – secondary stakeholders about its use. Being informed means more than being notified; being informed requires being able to interpret, comprehend, and remember that such recording is taking place. Being informed may also require being able to understand enough about the technology and its capabilities to imagine how and why the records might be used and by whom. Thus, simply alerting through traditional means of notification, such as signs, may not be a feasible solution, in particular for a mobile personal recording device like SenseCam.

These issues are particularly acute for people with disabilities (whether emotional such as anger management or cognitive such as from traumatic brain injury) who might be in most need of recording technologies. They might also be least capable of communicating with secondary stakeholders. Furthermore, the process of informing may cause a potential embarrassment and/or distraction from one's immediate task, both of which run counter to the reasons for using an assistive technology in the first place. For example, SenseCam might shield someone in the early stages of cognitive decline from publicly admitting memory impairment.

Throughout our study, concerns of both locally situated and institutional social dynamics arose repeatedly. Existing obligations between people, such as an employer and an employee or a storeowner and a shopper, inhibit their ability to enter freely into an agreement about use of recording technologies. Thus, an open challenge exists to create new policies and technologies that can support people in embracing or rejecting recording without requiring direct confrontation.

Finally, in addition to the socio-technical challenges, several organizational and governmental considerations emerged from this study. As nations continue to attempt to regulate and monitor issues surrounding surveillance technologies, exceptions may need to be made for certain uses and users. Participants in this study often equated these exceptions to concepts of prescriptions, which have been used to limit access to other therapeutic but potentially dangerous things (*e.g.,* steroids). Furthermore, as demonstrated in this work, some responses are common across cultures (at least within the four Western locations in this study), but others are very much influenced by the particulars of the location and its inhabitants. Whether through culture or law, the enactment of these local practices must be considered in the design and deployment of these technologies. In the future, countries may even initiate an approval process, like that for new medications, to verify appropriate uses for new therapeutic technologies within their national context and develop labeling and distribution processes to protect their uses.

RELATED WORK

Participants in this study often compared SenseCam to other technologies when describing their responses. In particular, they often mentioned video surveillance technology (*e.g.*, CCTV) and online photo sharing (*e.g.*, through Flickr or Facebook). Researchers have been studying these technologies heavily over the last decade, and a full review of these works is out of the scope of this paper, but we here highlight some interesting points in relation to our results.

Previous studies surrounding video surveillance technology in the UK report that most people accept the use of hidden CCTV although they did believe that CCTV can be abused [8]. Dixon *et al.* report that most people believed that they have the right to know when they are on camera. However, although in 1991 the majority of the participants wanted a large notice to inform them about the presence of cameras [14], by 2003, the majority no longer wanted these signs [8].

Not unlike with SenseCam, people today already capture digital recordings of themselves, friends, family members, and even strangers using digital cameras and camera-phones. Much of the studies of online services for sharing these photos and videos have shown that such websites default to sharing photos publicly when people would prefer to keep them private [8] and force the users to accept this default setting out of convenience [2]. That is, to manage how they present themselves, users must exert effort to manage the access rights to different images [24] and expect that others will register with the appropriate websites to view the photos. Moreover, Besmer and Richter Lipford have shown that some users hopelessly accept that privacy problems will occur in photo sharing sites such as Facebook, because the extent, activity, and accessibility of their social networks is beyond their control [4].

Some researchers have also been examining technological means for actively blocking photography (*e.g.,* [23]). In this work, however, we focus on the perceptions and preferences that might lead an individual to use such an application.

CONCLUSION

Novel ubicomp recording technologies represent some of the best of what the field has to offer – the ability to support critical human needs, such as memory augmentation for people with severe cognitive disabilities. At the same time, many of these technologies inherently require the gathering, saving, and sharing of immense amounts of potentially sensitive and confidential data. Thus, as they become more common, questions arise about how they might be adopted and appropriated on a large scale.

Understanding and reacting to novel recording technologies, like SenseCam, is a situated personal endeavor. Thus, in this study, we sought to uncover and analyze contextualized initial responses using the paratyping method. This method is designed to study reactions of secondary stakeholders to a technology they have likely never experienced previously. It allows for situated responses on a large scale through surveys distributed by proxies throughout their normal activities. This

research uncovered important trends in the way people who might be recorded by SenseCam interpret and respond to those encounters. People typically reported wanting to know about SenseCam and to grant permission for its use. They would rarely have asked for a record to be deleted, but they would like to be asked permission for it to be shared. Interestingly, these statements were consistent across all levels of confidentiality, a departure from a previous study of a mobile audio recording technology [15]. Overall sentiments, as well as some of the reasoning behind them, differed across the four countries studied, indicating some trends in how novel ubicomp technologies might be taken up in these different locales.

Results from a contextualized study such as this one contribute to our ability to understand the adoption and use of novel recording technologies. Although important, abstract queries of everyday technologies and evaluations of deployed novel applications cannot by themselves provide the depth of understanding needed to comprehend fully how people respond to and appropriate ubicomp technologies. The presented results complement those studies by providing situated and personal accounts of encounters with a specific technology, SenseCam. Thus, this method should be included as part of a suite of tools to understand design, use, and adoption of ubicomp recording technologies.

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