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OBSERVERS’ PRIVACY CONCERNS ABOUT WEARABLE CAMERAS

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by
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ABSTRACT

Recently, wearable cameras and glass-style augmented reality devices such as Narrative Clip and Google Glass have entered the market and attracted much attention from both industry and academia. These devices are designed to be extremely portable and convenient for the user to capture a log of his or her daily life; they also have significant computing functionality and can be connected to the Internet at any time. However, because of the portability and invisibility characteristics of wearable cameras, not only the end-users but also the observers, become important stakeholders whose feelings of privacy may also be affected by the use of these devices. Therefore, questions are increasingly asked about potential privacy threats and ethical issues of these devices including what content will be captured, who will use this information, and how this information will be used in future.

In this study, we address the observers’ privacy concerns about wearable cameras as they might be used and experienced in different scenarios by combining qualitative and quantitative research. We first conducted four focus group interviews to explore the observers’ general perceptions and concerns. Drawing from the feedback received in these sessions, we developed and fielded an online survey (N=400) to investigate observers’ attitude, reaction, dimensions of privacy concern and concern about diverse type of information in nine different scenarios. We found that these concerns and reactions varied across scenarios, because of differences in the activity locations, actions, purposes and degree of observer control. We also found that some observer characteristics were related to their reported privacy concerns, including gender, age group, technology use history and media exposure to privacy invasion news.

We hope this study can expand the research area, and provide insights for both companies who wish to develop commercialized wearable devices and for researchers who seek to contribute future design and research studies.
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Chapter 1

Introduction

Wearable cameras, one of the most popular technology novelties to emerge in recent years, are fitted up with various sensors that can collect a wide range of private information about end-users in real-time including their location, image, voice, health condition and so on. This level of personal information contrasts to that available in earlier devices such as surveillance systems, digital cameras and smartphones. Although wearable cameras have not been purchased and used by large numbers of people, the society, and even governments have begun to pose controversial issues about their use. For instance, some privacy rights groups question what Google will do with the personal and environment information collected from the users (E. Ackerman, 2013). Meese argues that relevant laws should be enacted laws of privacy because of emergency of Google Glass (Meese, 2014). The press has even reported cases of assault and abuse of who were using wearable lifelogging cameras (Wolf et al., 2014). As a result, it is essential for researchers from multiple disciplines to investigate the use and implications of these new wearable devices that include the wearable camera.

Previous research has explored the user’s concerns about wearable devices, and how to improve users’ acceptance and experiences of these devices (Lee et al., 2015; Spagolli et al., 2014). For example, Lee’s group found that the users concerned a lot about their sensitive personal information to be collected the device, and their concern differed according to who would be the final data recipient (Lee, 2015). While these studies have already provided frameworks for design of wearable devices and developed a number of features and prototypes aimed at protecting the security and privacy of information collected, only a few of them discuss
the observer’s attitude and acceptance as well as their privacy concerns of these devices (Denning et al., 2014; Singhal, 2016). Moreover, the previous work has not clarified which specific dimensions raise the largest privacy concerns by observers, or which kinds of wearable camera scenarios are most likely to worry observers.

To address this research gap, we conducted a deeper and more detailed investigation of about observers’ privacy concerns relating to wearable cameras. Using a combination of qualitative and quantitative research methods, we probed hypothetical observers’ privacy concerns relating to wearable cameras in several different scenarios, including the reasons for holding these concerns. We built a series of scenarios based on actions and locations that we expected to trigger varying degrees of privacy concern, and a series of questions were asked following description of each scenario. We examine the impact factors identified by previous studies and explore how the dimensions of concern and types of information differ across different scenarios. Further, we sought to determine if the predicted attitudes would be different if the wearable cameras are employed as assistive technology or as safety-assuring mechanisms rather than an individual consumer product.

We propose to answer three research questions here:

1. What is the observers’ perception of potential privacy concerns about the wearable camera when someone else is using it, across a range of scenarios varying in location and information sensitivity?

2. Which types of information are of most concern across these scenarios, and what aspects of each situation trigger the greatest concerns?

3. In what situations might wearable cameras be seen as more acceptable to observers even before these devices becomes common in our daily lives?

This study gives researchers and designers inspiration of further studies on how to consider trade-offs when attempting to consider the experiences of both direct stakeholders (users)
and indirect stakeholders (observers) in situations where wearable cameras are present. For product design teams in wearable device companies, observers’ and users’ perception of a new product are related to their potential market and revenue. They should also make the trade-off in product design according to the result of the study that some technologies will be convenient to users but resisted by observers and people who care social ethics. If society will resist the eventual product, design results may be banned by laws and policies of the future. For academic research groups, they can take the scenarios we examined in this study into account when they are exploring scenarios of wearable camera use. Also, similar studies might adapt the methods we use here to explore an even broader set of use cases. This study will help expand this research field, and demonstrate usable insights for future development and promotion the cutting-edge AR and ubiquitous computing devices.

**Thesis Structure**

The thesis is organized in the following way: Chapter Two presents the literature review of previous studies about privacy of surveillance systems, privacy of wearable cameras and frameworks of information privacy. Chapter Three previews the research question and research design. Chapter Four includes the method and qualitative data analysis results of focus group interview. Chapter Five shows the method and results of quantitative data analysis of online survey. Chapter Six discusses the effect of observers’ personal characteristics that were encoded and analyzed as covariates. At last, Chapter Seven presents the high-level discussion and insights as well as conclusion and limitation of this study.
Chapter 2

Literature Review

Wearable Camera Introduction

As the results of ongoing development of cutting-edge technology, digital cameras have become more portable with higher resolution, smaller form factor and larger storage. Users can wear these new devices (e.g., Narrative Clip, MeCam and Gopro) on the clothes instead of carrying a heavy camera in the bag. Meanwhile, glassed-mounted cameras have emerged as another form factor for a wearable computer that user can wear it as normal glasses but has the capability to capture image and process information. Google Glass is a signature product under this category and has attracted significant attention in the past years.

Figure 2-1 Narrative Clip - one type of wearable camera

Besides portability, wearable cameras can transfer data to smart phones or tablets by wireless transmission, and users can easily share the recorded photos and video immediately with others. This type of device brings convenience for users and makes the operation hands-free.
However, since it is hidden better and less noticeable when operating in comparison with digital camera and smart phone, it brings more privacy concerns.

**Privacy of Recording Technology**

**Privacy of Surveillance Systems**

Since people have been surveilled and captured by camera devices for many years, privacy issues are not a novel or emergent problem in the age of augmented reality. Early research in this field began in the 1990s (Honess et al., 1992) when surveillance systems, such as closed-circuit television (CCTV) were viewed as producing potential privacy threats. With the development of new technology, however, a broad variety of people’s private information has become easily accessed and shared by public devices in public places; this has raised an increasing number of privacy concerns (Nissenbaum, 1998). Friedman once conducted a study to explore the experience and attitude of both the direct and indirect stakeholders by installing an HDTV camera on a university building (Friedman et al., 2006); the study showed that the majority of participants showed expectation of at least a little privacy in public, and their judgments of privacy were based on several aspects such as physical harm and informed consent (Friedman et al., 2006). In the beginning of 21th century, CCTV was acceptable by the observers, and organizations installing such technology were not required to notify observers with a sign that they were being recorded (Dixon et al., 2003). The attitude of the public has changed since then, as people now expect to to see a small red light or another indicator that notifies when a camera was is capturing information (Honess, 1992). Indeed, the users’ and observer’s perceived privacy concerns have been changing and shifting over time (Smith et al., 1996).
To get a better understanding of these issues, Massimi investigated privacy issues by asking the participants to write diary entries about any kind of recording technologies they encountered in their daily lives; he reported that the stakeholders’ concern might be related to the people, places and activities surrounded them (Massimi et al., 2010). Nguyen probed several different dimensions of concern relating to information privacy when people were video recorded, including perceptions of unauthorized access or worries about secondary use by the third party (D. H. Nguyen et al., 2011). Although these studies were specific to observers’ reactions to CCTV, they form a basic set of privacy issues that may also plague the use of personal recording devices such as smartphones or wearable cameras.

**Privacy Perceptions Relating to Wearable Cameras**

Most of the previous studies about privacy concern relating to wearable cameras have examined issues from the perspective of the device wearer (the user); only a few have considered issues from an observer perspective. In general, the users of such devices tend to worry about whether their information might be stolen (hacked) if it is stored in a portable device and how the device itself is tracking their locations and actions (Lee, 2015). Also, the users manage their recorded content carefully by using strategies such as selective sharing and location-based decision making (Hoyle et al., 2014). When others around them are using wearable cameras, users expected that observers’ acceptance would be high, but clearly this result is biased by what users hope to gain from operating such a device (Hoyle, 2014). However, most wearable camera users do agree that the observers should be informed before the wearer starts recording (Hoyle et al., 2015). Koelle’s study found that people generally showed greater concerns about novel devices than established devices, that females were more concerned about their privacy and that not knowing whether or how the user will be using the device brings more privacy concerns to
bystanders; again however these questions were answered hypothetically by device users not members of the “audience” (Koelle et al., 2015).

As a pioneer in assessing observers’ perception of wearable cameras, Nguyen and his group conducted a series of in situ surveys and interviews in different locations and contexts, and found that as observed for the general case of surveillance systems, observers wish to be informed when they are being recorded and are more likely to consider these devices acceptable if they have a particular use for health care (D. Nguyen et al., 2009). To purposely address the observer’s perception on being recorded, Denning made use of similar methods to Nguyen’s study but focused more on privacy issues relating to device use (Denning, 2014). Participants were reported to have concerns about which activities relating to them were recorded, who used the device, where the location is, and whether they could be identified through the recorded images. Similar results were reported by Singhal’s group; that project included a comparison between smartphones and wearable cameras as well, where the researchers found that Google Glass was thought to be more “invisible” and that participants felt more uncomfortable with and more concerned about Google Glass than smartphones (Singhal, 2016). These studies take some initial steps toward understanding which factors might raise or lower the privacy concerns of the observers in different recording contexts.

**Context Variables that Influence Privacy Concerns**

As summarized in the previous section, privacy is context-sensitive (M. Ackerman et al., 2001; Nissenbaum, 2004). Observers’ perception might change because of the different time, location and activities, and people may be concerned about sharing one type of information in one context, but have no concerns about the same information in another scenario (Nissenbaum,
2004). One goal of this thesis project was to add to our understanding of different information concerns in different usage settings.

Types of Privacy Information

Researchers often have studied the borders of privacy such as physical walls, social borders, spatial borders and borders to ephemeral or transitory effects (Bohn et al., 2004; Friedewald et al., 2007). Based on such studies, a framework for creating scenarios for privacy research should be comprised of the actors, the environment, the activity, information flow, the control level and the enabling technology (Friedewald, 2007). Meanwhile, Finn and Friedewald expanded their four different categories of privacy and further conceptualized privacy into seven similar categories due to the change of information privacy; these include privacy of the person, behavior and action, personal communication, data and image, thoughts and feelings, location and space and association (Finn et al., 2013). In comparison with their model on ambient intelligence, the privacy of the image as well as thoughts and feelings are added, which are new challenges brought by emerging technology such as facial recognition and emotional computing. These technologies are also typical features of augmented reality devices that we should take into account when studying on privacy issues.

Information Capture and Usage Variables

Observers’ privacy concerns may be affected by how and for what purpose the information is recorded (Hoyle, 2014; D. Nguyen, 2009). For example drawing from the analysis of general privacy issues in information systems design, researchers have adapted the concern for information privacy model (CFIP) in several studies of wearable devices and augmented reality
The CFIP model posits several central categories of individuals’ concerns about how and why information is collected and shared: these include collection; unauthorized secondary use within an organization; unauthorized secondary use by third parties; improper access; errors; reduced judgment; and unintended combinations of data (Smith, 1996). Malhotra refined this model according to the emerging challenges in Internet information and proposed a model of Internet Users’ Information Privacy Concerns (IUIPC) (Malhotra, Kim, & Agarwal, 2004). IUIPC identified three categories of privacy in Internet Users’ Information including collection, control, and awareness and evaluated their causation with the users’ trusting belief, risk beliefs, and behavior intention (Malhotra, Kim, Agarwal, et al., 2004). These analyses associated with the CFIP and the IUIPC models are a useful starting point for exploring observers’ concerns about wearable cameras and similar devices.

Previous studies also reported that observers’ privacy concerns are related to who is using the information capture devices (Denning, 2014; Friedman, 2006). For instance, if a wearable device is used to assist with a health care issue (e.g. an assistive device for people with Alzheimer’s or Parkinson’s), the observers are more likely to accept someone using its use (McNaney et al., 2014). In work with smart cameras (e.g., cameras that can process and “see” the world around a person), researchers are exploring whether such devices could be helpful to shoppers who are blind or have a visual impairment (Yuan et al., 2015); such a situation might also be an example wherein observers would find image capture acceptable.

**Behavioral Context Variables**

Previous research has also pointed to contexts that may vary in their sensitivity. A variety of contrasting settings have been analyzed, including public plazas in a university campus where wireless Internet may be in use; the capture of personally identifying information in workplaces;
the invasion of wireless devices into more personal settings governed by social norms (bathrooms, bedrooms, in other’s homes); and places where camera recordings are typically off-limits by policy (locker rooms, theatres, government buildings) (M. Ackerman, 2001; Choe et al., 2012; Denning, 2014; Friedman, 2006).

In Massimi’s diary study of ubiquitous devices, scenarios were classified into three groups including private (for example, home), public (the street or a shop) and shared (an office) (Massimi, 2010), but the participants were asked to report any type of recording technology they encountered during the day. By using similar scenario design methods as we used in this thesis work, Koelle’s group drew illustrations of 14 scenarios to examine users’ perception about data glasses respectively for interpersonal conversations, (semi-)public spaces and working environment (Koelle, 2015). In each scenario, they set up several conditions that varied the visual information about the data glass user, his or her identity of the user and the purpose of the device (Koelle, 2015). This research is interesting, in that it used context-specific methods such as we have proposed for exploring observers’ reactions to glass-style cameras. However that project was focused on the data the glass users might be retrieving and viewing rather than on the devices as a camera or recorder. Nonetheless it will be useful to compare our findings to this study.

Friedewald summarized privacy-related scenarios that covered six application domains: home; work; health; shopping; mobility; and leisure and entertainment (Friedewald, 2007). We will use this analysis in combination with the others summarized here to design a relatively broad and inclusive set of scenarios in which a wearable camera might appear. There are no studies test these privacy issues for the case of wearable cameras in different context, or that probes types of information or recording processes trigger the greatest privacy concerns among different types of usage situations.
Technology Solutions

To reduce the users’ and observers’ privacy concerns and increase acceptance of novel technologies, researchers have explored technology solutions that would allow observers to avoid being recorded all of the time. One such approach is a technology that can send a notification of the recording activities to observers nearby and give them the controls to track the storage and usage of their data. Examples of this approach include the privacy awareness system for ubiquitous computing (Langheinrich, 2002) and NotiSense, an urban sensing notification system (Pidcock et al., 2011). Although interesting as a direction for giving observers some control over other users’ recordings, this technology must itself access and track location information of other users; thus it brings its own privacy concerns to the overall situation.

Another technology solution approach is to process the data collected during a recording so that no private information is stored in the device. In short, the technology is able to detect whether there are wearable cameras nearby and process any corresponding data streams based on the observer’s configuration parameters (Yus et al., 2014). Another example is the Candid system which addresses privacy concerns by combining the two approaches of notification and processing (Ens et al., 2015). Candid prototypes can work in different modes, ranging from only sending a notification, displaying the operation mode of the user to absolutely blurring the private information in the camera (Ens, 2015). Moreover, some technology can recognize a pre-defined gesture of the observers (e.g., an “X” to block out) and react to these instructions (Jung et al., 2014). These design concepts provide inspiration for future mechanisms that can deal with observers’ privacy concerns about wearable cameras, but none have been implemented and tested in real-world settings.
Summary

In previous studies, researchers have explored many aspects of privacy-invading situations and types of privacy concerns in information systems and Internet information. Although these factors are useful in building representative scenarios and assessment probes, none of the research has provided an in-depth examination of privacy concerns that observers may experience in the presence of wearable cameras and augmented reality devices. In fact, the largest body of research on how recording technologies have impacted observers’ perceptions has considered the case of public surveillance system such as CCTV. A few studies have investigated the observer’s privacy concerns relating to augmented reality, but these either have failed to find out which aspects of privacy are of most concern to observers or were a limited test of one specific scenario. I will address this research gap in my study, and find out the most privacy-sensitive scenarios, types of information, other variables affecting privacy concern, and observers’ general attitude to the privacy issues raised by the public use of wearable cameras.
Chapter 3

Research Overview

Before discussing the detailed methods used to collect and analyze data relating to observers’ concerns about wearable cameras, we briefly introduce our general approach, that is how we approached the research design, why we chose a particular set of research methods and what the advantage of selected methods.

For the sake of clarification, three concepts should be elaborated first before talking about the research design. The first one is wearable camera — this is the emerging technology we seek to understand in this study. The second one is observer, which refers to the people in a particular situation in which other people nearby are wearing this type of device. Prior researchers have at times used the terms “bystander” and “spectator” to represent this same stakeholder group; we choose to use “observer” because it is a more neutral term. The third one is user, which refers to the people who are using the wearable cameras, for example to record lifelogs or take pictures.

Research Design

Methods in Common Use

Previous studies of recording technology illustrate several sorts of methods that are important to consider. For example, some have used of a diary method wherein participants are asked to make reports about various recording technologies they encountered in daily life and how they may have reacted to these technologies (Massimi, 2010). The advantage of a diary is that the data can be collected in real-world settings without asking the participants to imagine the situations. However, because the data is self reported, participants may choose to report some
experiences but ignore other experiences (e.g., technologies they are familiar with that are thus less noticeable or remarkable). Also, this method is more useful for established technology than an emerging technology such as wearable cameras.

Other researchers have used interviews to address privacy issues. For example, Denning’s (Denning, 2014) group conducted a series of in-situ interviews about bystanders’ perspectives on recording technologies; Singhal (Singhal, 2016) used a similar approach to explore the bystanders’ reactions to Google Glass and smartphones. These methods can be very useful in collecting rich qualitative data but tend data collection and analysis can be time intensive if a large number of participants are engaged. As a compromise to gathering rich qualitative data such as this and minimizing the effort required, we chose to conduct group interviews using a focus group format.

Finally, survey methods are a very common method used to probe privacy issues from relatively large groups of participants. These methods can be useful for providing population-level summative findings and trends across a large and diverse population. For instance, researchers have studied both users’ and the observers’ privacy and risk perception of public surveillance system, general recording technology, smart phones and wearable device by using large-scale survey (Friedman, 2006; Nguyen, 2011; Felt, 2012; Lee, 2016). To build on these prior efforts, we chose to include survey methods in this thesis.

Method for This Study

Qualitative Preliminary Research – Focus Group

In our preliminary study, our goal was to collect general ideas about observers’ perceptions of wearable cameras. We intended to use the results of this qualitative study to inspire
and guide the design of a broader-scale survey; thus we sought to ask questions and gain answers that would encompass quite a range of possible reactions to the technology features and situations in which wearable cameras might appear. Therefore, we chose to conduct a series of focus group interviews, to reach out to a relatively large number of individuals but using an open-ended semi-structured interview format. Admittedly, this group interview format raises some limitations (e.g., the “parrot” effect where one participant simply echoes another participant’s comment, “me too”); more generally there may be a sort of “group think” phenomena in which participants show higher (or lesser) concern than they have because of being affected by the tendencies of the group. Despite these limitations, the relative novelty of wearable cameras led us to decide to use this format, because we felt that many individuals would not have much experience and could be more creative and “future looking” as part of a group discussion.

Based on prior studies and our high-level research questions, the main problems we will address in the focus group is to probe a series of privacy-sensitive scenarios and factors that might have impact on their privacy concerns. We prepared a guideline of questions regarding these issues and their general perception of wearable technology and wearable cameras (see Appendix C). The focus group interviews are organized in a semi-structured form, so the questions are subject to change with the progress of each focus group session. We planned to explore several privacy-sensitive scenarios that might be further refined and tested in the survey.

**Quantitative Research – Survey**

In literature relating to information privacy and recording technology, researchers have argued that the users’ privacy perception cannot be simply measured on its own; it depends on the context and scenarios (Ackerman, 2001; Denning, 2014; Nissenbaum, 2004). Koelle’s group designed 14 scenarios in 84 different variations to evaluate the participants’ attitude towards
augmented-reality glasses, and find significant difference between various scenarios (Koelle, 2015). We adapted this approach in our own scenario-based approach, designing a survey that asks participants to answer a same set of questions repeatedly in different scenarios, and contrasting these answers to see whether their perceptions in each scenario are different.

As part of an exploratory research project, a large-scale survey can help us investigate the questions whether hypothetical observers’ perceptions will change when situated in different scenarios, and whether the use of wearable cameras in daily life scenarios will evoke concerns that are tied to different types of personal information, or to how the recorded information is capture or handled by the user. At the same time, the primary deficiency of survey is that we can only get the summative results from their response; we have little opportunity to further investigate the reasons for their self-reported reactions. Nevertheless, given that so few studies have been conducted to assess observers’ privacy concerns regarding wearable cameras, we can first address the “whether or not” question, and leave the more detailed exploration of reasons to future research.

In summary, we decided to use a mixed methods approach, combining both qualitative and quantitative methods to explore the observers’ privacy concerns relating to wearable cameras. The questions used in focus group interview were guided by prior empirical studies, while the results of these group interviews were used as an aid in designing the privacy scenarios and the related probes in the survey. The method and data analysis of focus group interview and the online survey are introduced in details in Chapter 4 and Chapter 5.
Chapter 4

Preliminary Study: Focus Group Interview

Chapter Preview

In this chapter, we introduce the data collection and analysis methods we used for the focus group interviews, where we employed a mix of direct and conventional analysis methods (Hsieh et al., 2005). Before diving into the analysis and interpretation, we first elaborate on the methods that we employed. Next we discuss the observers' general attitude to wearable cameras and factors involved in their privacy concerns including privacy-sensitive scenarios, type of private information and dimensions of concern. We follow this by comparing reactions to wearable cameras to those related to existing technology. Finally we discuss comments relating to perceived value of such devices.

Focus Group Interview

The main goal of the preliminary study was to explore people’s general ideas about what it would be like to be an observer when a wearable camera was in use; we planned to use these data to guide our survey design. We conducted semi-structured interviews in a group to do this, so as to collect ideas from a relatively large group of participants in a relatively short time. It also gave us the opportunity to collect as broad a range of opinions as possible, from group discussion.

We mainly explored the following issues in the focus group interviews (details of interview guideline can be found in Appendix C):
• The participants’ general ideas and previous experiences of wearable devices and wearable cameras.
• The participants’ concerns about wearable cameras as observers.
• Factors that may have impacted their ideas.
• Perceived differences between wearable cameras and other current image capture technologies.

Participants were recruited from several undergraduate level courses in a college of information sciences and technology. Researchers posted and announced the recruitment in each class and students interested in our project could sign up for one session of the group interview. In total we recruited 28 undergraduate students participating in four group interview sessions; they were given extra credit for their classes after successfully participating the focus group discussion.

Because of our recruitment method, most of the participants were aged 18-22 years. Although most of them had a general idea about wearable devices and had observed some usage of wearable cameras, only a few of them had ever used this type of device. Furthermore, among the 28 participants, 21 participants were from Information Sciences or Security and Risk Analysis major, who had deeper understanding of and were more sensitive to information privacy issues. These participant characteristics are summarized in Table 4-1.

Table 4-1 Demographic Information of Focus Group Participants (N=28)

<table>
<thead>
<tr>
<th>Variables</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
</tr>
<tr>
<td>18-22</td>
<td>27 (96.4)</td>
</tr>
<tr>
<td>23-26</td>
<td>1 (3.6)</td>
</tr>
<tr>
<td>Ever heard the term “wearable device”</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>27 (96.4)</td>
</tr>
<tr>
<td>No</td>
<td>1 (3.6)</td>
</tr>
</tbody>
</table>
We conducted four sessions of focus group. Each session was formed by six to eight participants and lasted from 40 – 70 minutes. Before starting the focus group interview, a video (https://www.youtube.com/watch?v=FCRuUsfI_cA) was displayed by the moderator; this gave the participants a brief introduction about the general functionality and some usage scenarios of wearable cameras. We used this video to help participants, especially those who were unfamiliar with this type of device, build an intuitive impression. Then, the participants answered and discussed several questions with the moderator as well as other participants. We audio recorded all of the four sessions and transcribed them for further analysis.

**Data Analysis**

In order to characterize the participants’ perceived privacy concerns and the factors that might affect these reactions, we began transcribing and coding the focus group interview after the first session, in case there were unexpected issues that we could probe in subsequent sessions. In the analysis process, we made use of both direct and conventional content analysis (Hsieh et al.,...
We adopted several themes from the empirical literature, including type of information, information control and practice, as well as privacy-sensitive scenarios (Dinev et al., 2009; Friedewald, 2007; Malhotra, 2004; Singhal, 2016; Smith, 1996). Meanwhile, we used open coding for comments that did not fall into any existing categories.

The same open coding method was also used to analyze what participants offered as their reasons for the cited privacy concerns, ideas about using wearable cameras as personal assistive devices and public safety devices as well as ideas about comparing wearable cameras with smartphones and public surveillance systems.

As we went, we slightly modify the focus group questions based on the findings from previous session. For example, we found the participants discussed more about general wearable technology than wearable devices, so we changed and merged some questions about wearable technology in the following sessions. After four sessions, we found that there were no new categories emerging. Therefore, we stopped the recruitment and finalized the analysis. By using these analysis methods, we were able to discover the participants’ general ideas and previous experiences of wearable devices and wearable cameras, the participants’ concerns on wearable cameras as observers, factors that may have impact on participants’ ideas and their perceived difference between wearable cameras and current image capture technologies. The categories generated from focus group interview are shown in Figure 4-1.

The findings and the participants’ statements were reworded to form questions and choice options in the following online survey. In the next section, we summarize the results of preliminary study.
General Attitude

Perceptions of Wearable Cameras as an Observer

As an early-stage technology, our focus group interviews suggest that observers may begin with an attitude of cautious acceptance about others’ use of wearable cameras. They did not share any severe disagreements about using this type of device, although they did express several concerns. The thought of a continual recording of everyday life in public places makes them feel uncomfortable and annoyed; some participants used the word "creepy" to describe this situation. It seems that people have a fear of being recorded, especially by strangers. To be potentially recorded by a person without knowing who the person is and whether the person is recording, it is difficult to build the trust they think is needed in use of wearable cameras. As one participant said:

[G3-P7] “I could be slightly kind of uncomfortable because one is like they stand out a lot and then when I wouldn't know what's like the person is doing at all ...so there's really like no absolutely no mechanism of trust, and in there I feel there's no way to build that in.”

Meanwhile, there is more possibility that use of wearable cameras will invade their privacy. Because of the portability and invisibility, a user might wear it and record all day long, without other people's notice. In this situation, the observers feel they should be more careful
about their communications and activities. Therefore, their acceptance depends on the condition that the users would not record everything regularly.

Nevertheless, some participants mentioned that they would not mind others using wearable cameras in public places and gave several reasons. First, it is legal for people to record already, using other devices; and people should be free to wear the devices they choose. So, the wearable camera is just one form of image capture devices, just as as others are already available (e.g., a phone with a camera); it would be hard to restrict the utilization of this type of device.

Also, if a user intended to record someone else, he or she already has access to equipment that can achieve this in relative secret. The purpose of using wearable cameras is not candid recording. Furthermore, our participants argued that people feel uncomfortable primarily because it is a novel and unfamiliar technology. As people become more familiar with it, there will be fewer concerns about it. According to several participants:

[G2-P2] “I don't really have the issue. there's one thing I consider early is in the public environment, I can take out my phone right now and use it to record everyone.”

[G3-P5] “I just feel like with technology to located at your pen and you set up like a really small camera something already exists, so I'm not sure I like how concerned about.”

[G3-P3] “I feel like people are becoming less and less worried about privacy... I feel like you soon we're just not really going to thus care, so it might be like something everyone use it...”

Privacy Scenarios

Our participants also discussed the scenarios where they would be more or less likely to have privacy concerns if someone else using a wearable camera. In detail, they considered their likely acceptance according to three aspects: the location, and two influence factors, which are
activities they will have and identity of the user. We discuss each of these aspects respectively in the following subsections.

**Location**

The scenarios that evoked the lowest privacy concern are ones involving public spaces such as the street or a store. The participants mentioned that these ordinary places that are part of everyday life would be okay for them, even if they saw someone else using a wearable camera. Meanwhile, although the bank is also a public place, people still felt they would be concerned because financial information is very private information for almost everyone; other private personal information such as a Social Security Number might also be disclosed in this scenario. As said by one participant:

[G2-P7] “If you are walking to the banks, you can record the account numbers, route numbers, credit card numbers, and lot of the personal information, social security numbers.”

Additionally, as reported in previous studies (Denning, 2014), the participants felt they would be concerned about the use of wearable cameras in some places where recording should be forbidden according to social norms and policies. For instance, in the bathroom or a locker room, no one would expect to be recorded by any devices. Recording is also prohibited in theaters, museums, cinemas and other places where the content on display is protected. One decision rule seems to be that if people would not be allowed to use digital cameras or smartphones, they should not be able to use wearable cameras, either. Furthermore, in a classified professional working environment, the company or the organization would not let employees bring in and use any device with recording functions, so as to avoid unintentional sharing of confidential information. Concerns of using wearable cameras in these scenarios are similar to using other
image capture devices. However, since wearable cameras are more likely to be hidden, it might be more difficult to enforce the rules.

[G2-P1] “... but I can definitely see that if you want it to a movie theatre I will let you to take it off because they don't regular allow recording by a phone or another.”

[G4-P6] “I would say we going to corporate sense I could see how like a lot of companies are probably be like you can't. Like I know that there's already a lot of restrictions on like you know what you can look at on your cell phone, especially if you're in some sort of classified area, you can't even bring cellphones in.”

Another place where the participants felt they would have a high privacy concern is in a private property such as one’s house. As discussed in the literature, people perceive home as a private place where they can feel comfortable to stay and relax and have the strongest power to control things happening in this place (Nissenbaum, 2004). Therefore, if using wearable camera makes the house owner feel uncomfortable, the user should stop using it.

[G4-P5] “but like if you were coming into my home or something like that with Google glass, on I would probably be a little bit freaked out and not want you wear that.”

Activity

Besides the location, the ongoing activity of the observer is a key factor that seems to affect privacy concerns. For example, the participants did not expect to feel privacy concerns when they are behaving normally in their daily life, perhaps walking down a street or shopping in a store. Because there is no private information being shared in these scenarios, the recording would not bring any risk of information disclosure to them. However, if they perceive their
actions as improper, revealing or for some reason embarrassing, they will be more careful when seeing wearable cameras nearby and they would try to avoid being recorded.

[G1-P5] “Most of the stuff I do every day it’s not a big deal if people know about it or know where I am.”

Moreover, our participants discussed their concerns related to social interactions. Social situations, including personal conversations or casual communications, always takes place between one or more partners. Therefore, people do not want the content of these interactions to be recorded or distributed to others. Meanwhile, these social exchanges are also seen as a sort of ephemeral interaction (Friedewald, 2007). Thus recording a conversation that people expect to be forgotten soon, seems to invade their privacy borders and make them uncomfortable (Bohn, 2004). One participant said:

[G3-P7] “I did pretty much care about every social situation when you expect privacy, that expectation is kind of off the table. If either party or both have wearable technology on them.”

User’s Identity

Lastly, our participants care a lot about the identity of the person who is using a wearable camera. Given the computational capability of wearable cameras, being recorded by someone unknown to us will be riskier than if it is done by an acquaintance, because the result record may be disclosed to other unknown persons or entities without any notice or authorization. As some participants said, they do not have any concerns or uncomfortableness when seeing their friends and classmates using a Google Glass. They also feel researchers are free to use the device after notifying them the purpose of recording. In general, if the user is perceived as trustworthy, the observer’s privacy concern will decrease.
“for right now, you record the video for the research, we come here just for extra credit, so I don't mind”

However, some situations will evoke more privacy concerns if an unfamiliar user seems to record intentionally. For instance, as described by one participant:

“If I see some like 50 year old guy doing it at a pool, and looking at a bunch of kids, then I will be more skeptical.”

In this scenario, the identity of the user in combination with his apparent intent raises the person’s suspicions; kids who are there under their parents’ protection should not risk being recorded by strangers. The parents or another administrator would and should ask the user to refrain from taking pictures, perhaps even to leave the location.

Therefore, when designing scenarios for examining the observers' privacy concern, we consider the three aspects as a whole to build the details. (table 3-2)

**Type of Private Information**

We based this theme on literature that has described seven sources of private information (Finn, 2013): privacy of person; behavior and action; communication; data and image, thoughts and feelings; location; and association. In the focus group interviews, we explore whether the information focus of participants' privacy concern of wearable cameras might also fall into these categories and whether there is any other type of private information that is of concern.

Our participants mentioned several concerns about the privacy of a person. However, beyond thinking about their body functions and body characteristics, they also raised concerns about other personal information such as age, social security, and home address. Among these many types of information, any single piece of information will not evoke high privacy concerns
individually. However, if several kinds of information are combined with each other and make it possible for others to shape the observer's identity, people will feel it brings more risks than collecting a single kind of information. Moreover, wearable cameras such as Google Glass can not only record this information, but may also be able to analyze such information automatically and immediately. The result may be increased convenience for the users (i.e. they will know more about the visual information around them), but more dangerous for the observers to disclose their information.

[G2-P4] “Everything can let you find me like basic information, even like phone number, signature, something like that. I feel like should be kept private.”

[G3-P7] “But somebody may compromise that you are wearing google glass, and you see everybody here I can have the profile, and get all information about your surroundings.”

We also discuss users’ recording-related actions and communication in next part when discussing factors that influence reactions to privacy scenarios. Meanwhile, many of our participants mentioned financial information as their concern. Obviously, personal property is one of the most important and private things of people. In these days, since real estate and value products such as jewelry and collections are difficult to be stolen, our participants' privacy concern for financial information focused more on bank and credit card information. Because of invisibility characteristic of the wearable camera, users can easily record the information without the observers’ notice when they are filling out forms in the bank or paying by credit card in stores. As one participant stated:

[G3-P5] “like the one that I can think of would be an environment like an ATM or something, and I'm like typing in my passwords are codes to my account. I can imagine it will not be too hard for someone with a camera that getting a person see my account information.”
Finally, we identified examples of eight types of private information including personal characteristics (such as racial, gender and so on), images and videos, current action, current communication, current emotion and facial expression, association and companions, current location and financial information, to be evaluated by the participants in the online survey.

Information Control and Practices

There are many variations in how users of wearable cameras might share control of the recorded information, or how they intend to use it once it’s recorded. We propose that observers’ privacy concerns may differ based on such factors. In Smith’s CFIP model (Smith, 1996), privacy concerns are divided into seven dimensions including collection, internal unauthorized use, external unauthorized use, improper access, errors, reduced judgment and combining data. Working from our focus group interviews, we sorted the privacy concerns into three categories. We discuss each of them in the following subsections.

Without Control

In general, observers do not expect to have control over how a wearable camera is used. We have already pointed out that unknown users are less likely to be trusted and raise more potential risks of information disclosure. Meanwhile, when seeing use of digital cameras and smartphones, people can tell whether the user is recording or not through the indicator light and point direction. However, it is hard to tell whether a wearable camera is recording or not without any notification. Therefore, they are concerned that they have no way to control whether information is collected or not (if they knew it was being recorded they could at least ask the user
to stop). Under this circumstance, people should always be careful about protecting their private information in public.

Moreover, even if features are added to the wearable cameras to signal whether the user is recording or not (e.g., a sound or a light), it is hard to know whether and what information is intentionally or accidentally recorded. As mentioned above, people do not have much concern about their normal actions in general public spaces. However, sensitive information and improper activities will trigger higher privacy concerns of the observers. From one participant:

\[G4-P5\] “but this is becoming a thing that people are aware in this, and then you do something wrong, and then there's backlog on you.”

**Reuse, Modification and Publish**

Information stored statically in a device will not bring severe risks, but the participants assumed that any such information might well be reused or distributed. First of all, they have concern that the user will reuse the information for personal purposes after recording. Similar to other image capture devices, it is hard to determine the copyright status of the recorded content, and the observers are even unable to know whether and how the information will be used. Thus, we consider it as improper reuse and modification by the user.

\[G1-P6\] “But if they just make for personal use like something that may be concern.”

Also, the information may be reused by other people or even organizations. One participant gave the example that wearable devices could track personal fitness habit and evaluate their health condition. The health insurance companies will use these records to raise the quoted price if one person seldom engages in fitness training. Although this is not specific to wearable camera usage, we can expect that similar case will happen. A more serious situation would be
where the information is distorted purposely and wrongly interpreted by others, such as falsification of evidence shown in films and news report. Our participant mentioned this:

[G4-P5] “I think that's a huge thing because if your voice is recorded, they have that capability to take what you said, and distort it however they want. They can rearrange your words against, twisted make it sound like you said one thing that you didn't even say at all.”

In current age, people are accustomed to post anything onto public networks such as social media and discussion forums. Because our participants are college students, we expect that they are frequent users of social media. Therefore, many of them referred to concerns of the recorded information being posted online. While unauthorized recording is an inappropriate action, posting the contents to Internet is direct information disclosure and will bring more risks for the information owner. Additionally, wearable cameras can be connected to the Internet easily, and more and more people have begun to use cloud services instead of local storage. If a recording is stored in the cloud, there may be even more risks such as being hacked and improperly accessed by a third-party person or organization.

[G4-P3] “I guess the main concern will be like if they're taking pictures of people, or recording them, you know, what they're doing and posting on Facebook or anything. Everyone likes posting on Facebook. So now I'm now knowing what they are exactly doing with it could be scary.”

**Real-world Risks**

As a result of the privacy concerns discussed above, our participants had concerns about real-life risks that could be evoked by information disclosure. With the development of Internet and social pattern changed online, the border between online and offline information and identity
is fading away gradually (Acquisti et al., 2015). For instance, when talking about location tracking and sharing, people always worry about whether their accurate home address will be tracked and others can use this information to invade their lives. As an observer of wearable cameras, anything and any person we meet, and any place we go to in daily life, will be potentially recorded. In addition, this type of device provides a way to easily connect these kinds of information with personal profiles by automatic detection and process. Therefore, more real-world information will be collected, published and accessed on Internet, and the information will result in risks in real life. Said by one participant:

\[G1-P4\] “If they can track your locations and if you are not home, the robbers can come or something like that.”

**Comparison with Existing Image Capture Devices**

Several types of image capture devices are commonly available, such as digital cameras, smart phones, public surveillance systems (PSS) and so on. In the focus group interviews, we asked the participants to compare wearable cameras with smart phones and public surveillance systems regarding their privacy concerns, and to offer reasons for their concerns. We report these comparisons in three parts: device owner, visibility and recording view.

The first difference between wearable cameras and existing devices is the owner of the device and records. Although wearable cameras have not exploded in the personal consumer market yet, according to advertisement and introduction of devices such as Google Glass and Microsoft Hololens, we assume that they will be targeting people who are already using smart phones. In contrast, PSS are typically installed in public spaces with safety surveillance requirements, and managed by relevant organizations. For example, cameras installed in traffic accident hazardous locations are operated by government and the police. The parking lots of big
department stores are managed by the company. Because our participants expressed higher trust for these authorities and organizations than individual users, their privacy concern about wearable devices are much greater than PSS.

[G1-P6] “But because it's kind of different cause some of the cameras in public that is controlled by the police or by the government. They will not use that to do something else. But if it's from personal you don't know what who is a person, where he is from, what kind of video he's recording and what kind of use so, that's kind of concern.”

Another concern is who will review and use the records. Because PSS are operated and managed by governments and organizations, the records will only be reviewed when something happens and part of the records are useful. Meanwhile, in their charge, it will be difficult for the records to be hacked or accessed improperly. However, individual consumers of wearable cameras may well modify and publish the records intentionally or accidentally, which brings more risks to the observers than PSS. As one participant said:

[G2-P3] “I think the CCTVs are much safer, because not everyone has the authentication to use that. ... and for the wearable device, you don't know anything, and they are not that safe as a CCTV and people might post them on YouTube.”

Our participants also mentioned that wearable cameras are hidden better than surveillance cameras and smartphones. PSS exist in public spaces, and the cameras have relatively large sizes, which make them more easily noticed and recognized. In some cases, such as in traffic accident hazardous locations, there are signals to show that this place is under a camera monitor. And to use a smartphone to capture an image, the user must bring it out of pocket and hold it in the hand. However, wearable cameras can be very tiny and attached unobtrusively to our clothes. They can be designed to be a pair of glasses, a wrist band or even a button. No one will notice if the user is
constantly recording. Therefore, the participants perceive visible devices much safer and consider invisible wearable cameras evoke more privacy concerns.

[G2-P8] “It is hard to notice that somebody use it (wearable device) to take photos... but in America it's fine, because they put up big sign to notice others there's (public) camera detecting. So that will be good.”

In consideration of the flexibility of recording between wearable cameras, smartphones and PSS, our participants feel that PSS triggers fewer privacy concerns than wearable cameras. Cameras of surveillance systems are installed in fixed locations and pointing at a single view permanently. They keep recording the same place instead of changing their focus all the times. Therefore, people can actively avoid being recorded when they find PPS existing (just walk to a different location). Also, the indicator light is always turned on when a surveillance camera is recording. However, because wearable cameras may be mounted on the head or attached to clothes, it is hard to know the current view angle of a wearable camera, and therefore hard to infer what content or even whether the camera is recording. People cannot tell whether they have been captured or not, so they feel that they must be more careful about their actions and in general have more concerns about private information that may be recorded intentionally or accidentally.

[G1-P2] “Like the CCTVs they are just it's their areas so they're looking after their place, so I think they have the right to do that because the only focus on one area.”

Although it is also easy to use smartphones to record, the user must hold and point the smartphone directly toward someone if the user intends to record, and current smartphones seem to be evolving to be even larger and thus more obvious when in operation. In this case, the observers can decide whether they are being recorded. In short, wearable cameras offer the most flexibility for recording, and therefore bring the most privacy concerns.
Values of Using Wearable Cameras

Values are defined as the people’s preference of how wearable cameras should exist as an individual consumer device and how the device should be utilized by end users. It is important for the design and development team to know the stakeholders’ values before they publish a new product, which will directly affect the society’s acceptance of the product. In the focus group interview, the participants discussed their values of wearable cameras in two aspects: user factors and external factors.

User factors relate to the actions that users should take when they are using wearable cameras. The participants felt that people should ask for permission before they begin to record, especially in privacy-sensitive scenarios. Although the observers might still say that it is okay to capture, the consent can work somewhat like the indicator light of other cameras, which represents a signal of being recorded. Meanwhile, in public spaces, they should not capture images or videos of any person intentionally without consent. They also think the users should drop a boundary in their mind between public and private regarding the observers’ locations and actions. Same values can be applied to digital cameras and smartphones. But because of the portability, invisibility and flexibility of wearable cameras, the users can record in a much freer manner, and they will more possibly take this advantage and abuse wearable cameras. As our participants mentioned:

[G2-P3] “I really don't like people take video recording without my permission. but if you ask and I might say yes (or no maybe).”
“... if somebody close to me wears one, I would just trust they would know when was the public moment and private moment. not record, that would be perfect.”

Besides user factors, external factors are also discussed by the participants. First, relevant policies and regulations are big issues from their point of view. The policy should not only regulate how and whether wearable cameras will be used in public spaces, but also relate to the regulation of purchasing such devices, such as a background check before purchasing one, especially when using it as an assistive device. One participant imaged that signal of “No Google Glass” would appear in theatres and museums in future.

“I don't think anyone should be able to buy it. I think you need background check or something like that before you can just buy a google glass. Cause it's creepy you will get it it's not good.”

Meanwhile, the participants also mentioned the regulation of designing such devices. Similar to regular cameras, the development team should add indicator light or other features on wearable cameras to represent the recording status. When knowing whether the device is working or not, the observers will feel much safer and reduce their privacy concern about being recorded continually. Some participants also argued that in order to avoid abuse, the design of wearable cameras should be standardized that all the wearable cameras have same appearance and colors. This type of design will reduce the risks brought by invisibility, and the observers would be able to find wearable cameras in the surrounding environment and be more careful about their actions. Anti-recording applications are also the expectation of our participants from the observer’s side. When a wearable camera is working, the application will be able to tell whether there is such device recording nearby. Moreover, it can blur the face and important information of observers to protect their privacy. The following are our participants’ ideas:
[G1-P2] “But like having a different light when cameras on, like when recording it's red. Other than that, it's pretty if it's off, you don't really care and just walk along by.”

[G2-P2] “there's once a time that everybody is wearing it, that will be some apps in digital tell you that this person is recording you. that way seems to be fine.”

In this chapter, we have analyzed and discussed the findings from focus group interviews. The reactions and discussion of different camera usage scenarios provided guidance and rationale when we built the nine scenarios tested in the survey. We also were able to generate parts of the survey questions from what the interviews conveyed about types of private information and dimensions of privacy concerns. Questions about the comparison between wearable cameras and existing image capture devices are examined in the survey as well. In next chapter, we introduce the methods, analysis process and primary results of the online survey study.
Chapter 5

Summative Study: Survey

Chapter Overview

In this chapter, we summarize the methods we used to design and field the online survey, as well as reporting the detailed analysis and findings from the online survey. The first section briefly describes how we developed the survey questions and scenario designs from a combination of published literature and the preliminary focus group study. The second section introduces the survey structure, data analysis methods and the general demographic information of the participants. The third section discusses the participants’ privacy reactions to the different possible usage scenarios. The fourth describes their general ideas about using wearable cameras as personal assistive devices and public safety devices as well as the comparison between wearable cameras with the smartphones and public surveillance systems. The final section presents other findings of interest.

Survey Design

Survey Questions

The main research question we would like to address in this study is how the observers perceive the use of wearable cameras in various scenarios, and which factors will affect their privacy concerns. Thus, we briefly categorize the survey questions into two parts: scenario-based questions and general attitude questions. Scenario-based questions are contextualized by a specific scenario. The participants evaluate and answer the question based on what they believe
their perceptions would be for a hypothetical usage scenario instead. In contrast, general attitude questions appear after the scenario-based questions, and ask participants to answer them using their knowledge of wearable cameras without considering a particular situation.

**Scenario-Based Questions**

We explored three aspects of possible privacy concerns using the scenario-based questions, drawing from previous studies about information privacy and recording technologies. These were acceptance, concern and reaction to the device (Friedman, 2006; Massimi, 2010). As Koelle stated, observers preconceived that glass-mounted wearable camera are always recording, which negatively affects their acceptance (Koelle, 2015). Therefore, we inject the acceptance question in various scenarios using two dimensions: whether or not they can accept the use of the device and whether or not they are informed about the recording status of the device. Given these variations, we examined whether the observers would react differently, and which strategies they would use to avoid or minimize the impacts of unauthorized recording by people using wearable cameras.

In addition, as discussed in Chapter 4, we wanted to explore observers’ privacy concern as it relates to different types of information, and how they perceive the potential usage and process of the recorded information differ in each scenario. To do this, we leveraged the seven types of privacy information proposed by Finn et al. (Finn, 2013). By extending this set with the category of financial information (from the focus group interview), we presented the participants with eight types of private information to evaluate for each scenario respectively. In addition, our focus group participants expressed concerns about information control and information practices by the user and other third-party people and organization. Therefore, we also included ten issues
related to these concerns, drawing from published frameworks (Dinev, 2009; Smith, 1996) and what we learned from our focus group interviews.

**General Attitude Questions**

At the beginning of the general attitude questions, we ask the respondents about their acceptance and concerns, and let them evaluate the reasons for their concern in terms of legality, perception of recorder, identification, personal interest, public familiarity (Denning, 2014) and characteristics of wearable cameras. These questions will help us to address why or why not they can accept and have concern about wearable cameras.

Additionally, we explored whether the participants might change their attitudes in some special cases such as using wearable cameras as personal assistive technology and public safety device. In the focus group interview, our participants show high acceptance of wearable assistive technology with empathy to the people who need help. We consider that if wearable camera is used for personal assistance, it may be much easier for the observers to accept it. As well, because public surveillance cameras have already been in use for many years, we assume that to replace fixed cameras with wearable cameras may have a big impact on reactions.

In addition, as we summarized in Chapter 4, we find that the observers have different privacy concerns when comparing wearable cameras with existing recording technology. We decided to further explore these issues in the survey, and find out which are the dominant reasons why the observers perceive wearable cameras to bring more privacy concerns than smart phones and public surveillance systems. For instance, do they consider that individual personal users are less trustworthy than authorities and organizations? We think that the comparison will give us insights into how to design more acceptable and trustworthy wearable cameras.
As previous studies state, people’s attitudes, beliefs and values are connected to each other (Dinev, 2009). Therefore, after examining their general attitude, we try to discover the participants’ current values and beliefs of wearable cameras. Belief refers to how people think the users will use wearable cameras, and value refers to how they think the device should be used. With knowledge of their beliefs and values, we will be able to know how people perceive wearable cameras as a whole in current stage, and the results will facilitate future research to compare the change of their attitudes, beliefs and values over time (Dinev, 2009).

**Covariates**

In previous studies, researchers have shown that several personal characteristics – such as experience of technology use, familiarity with the device, gender and age group – are associated with people’s perceptions of information privacy. Thus in our survey we included four different personal characteristics to use as covariates for further analysis. First, we asked about the participants’ usage history of *common technologies* including computer, Internet and smartphones. Second, we asked about exposure to *wearable technology*. They are asked to choose whether they have once used wearable technology, whether they have heard wearable cameras and Google Glass and whether they have tried wearable cameras by themselves. We have the hypothesis that users and non-users will have different perceptions. Third, we asked about their *privacy invasion experience* that is whether their information has ever been disclosed or whether they have been exposed to news stories about privacy invasion. Finally, we collected general *demographic* information including gender, age group, education and income.
Scenario Design

Scenario Building

Besides the questions discussed above, the other essential part of the survey is the scenarios used to contextualize the scenario-based questions. In this study, our main goal is to explore their perceptions of wearable cameras in daily life. Therefore, we followed two general guidelines for designing these scenarios:

1. The scenarios involve locations and activities familiar to the participants in daily life.
2. In each scenario, the user is a stranger to the observer without any special identity.

Rosson and Carroll describe a scenario design process that follows a framework of “problem scenarios” that are then used as motivation for increasingly more detailed design scenarios including “activity scenarios”, “information scenarios” and “interaction scenarios” (Rosson et al., 2002). Although we are not designing scenarios from a user perspective, we still follow this framework when analyzing the comprising factors of scenarios and building them. According to the framework, the general problem scenario was “observers see someone strange using a wearable camera”. To elaborate this scenario, we used two factors to consider alternative versions; these were the location of the wearable camera encounter, and the observer’s activities.

Table 5-1 Locations for Wearable Camera Scenarios

<table>
<thead>
<tr>
<th></th>
<th>Level of Privacy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Attractions</td>
<td>Fitness Center</td>
</tr>
<tr>
<td>Street</td>
<td>Party</td>
</tr>
<tr>
<td>Grocery Store</td>
<td>Office</td>
</tr>
</tbody>
</table>

From literature and our focus group interview, the possible locations for wearable camera use (including the presence of observers) can be classified into three categories that vary in level of privacy concern: public spaces, semi-public spaces and private spaces. Public spaces generally
do not involve any private information directly and people pass by these places quickly without constant stay. Semi-public spaces are shared spaces with other because of similar interests such as bars, fitness center, party and office. People visit these places for some purpose and will stay there for a while. In contrast with public spaces, some activities happening in these spaces might be experienced as private for people. Finally, people visit some places where private information is always involved to achieve a special purpose or activity, for example a hospital or bank. Such a space might also be one where people do not normally interact with strangers because of a boundary that keeps other people out unless they have permission. We use the concept of a private spaces to cover these cases. According to this analysis, we selected nine representative locations shown in Table 5-1.

Observers’ current activities can also be separated into three levels. First, there are some activities that our focus group participants seemed not to mind being recorded; these were activities such as sports, walking around, or carrying out the normal activities of daily life. Other activities may involve information that can raise risks relating to personal safety, or that may affect their daily lives. For instance, some participants care about their social interaction and personal interest. Finally, there are some activities which are quite privacy-sensitive. If information in these activities is disclosed, the observers have high risks that their daily life might be affected by the disclosure. Visiting doctors for health issues, working in confidential content and paying by credit card are activities belong to this category. Following this analysis, we selected nine types of activities listed in Table 5-2. One constraint was that each of these activities must be possible in the locations already defined.
Table 5-2 Activities to Form Privacy Scenarios

<table>
<thead>
<tr>
<th>Level of Privacy</th>
<th>Low</th>
<th>Mid</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travelling</td>
<td></td>
<td>Dating</td>
<td>Making payment by card</td>
</tr>
<tr>
<td>Fitness Training</td>
<td></td>
<td>Costume unusually</td>
<td>Working with confidential content</td>
</tr>
<tr>
<td>Get-together</td>
<td></td>
<td>Talking about family issue</td>
<td>Discussing health issues</td>
</tr>
</tbody>
</table>

As seen in the two tables, each contributing factor (Location and Ongoing Activity) had three different levels of privacy from low to high. We combined the two factors to generate nine different “activity scenarios” that took place in the nine different locations. Simple stories were developed to motivate the appearance of a wearable camera while the observer was engaged in the given activity. The resulting scenarios are shown in Table 5-3.
Table 5-3 Scenario Tested in the Survey

<table>
<thead>
<tr>
<th>Activities</th>
<th>Locations</th>
<th>Low</th>
<th>Mid</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low</strong></td>
<td>You are now traveling to other cities. At a scenic attraction, you park the car, enjoy the scene, and plan to take some photos. At this moment, you notice another tourist is wearing a glass-mounted camera.</td>
<td>You have a habit of doing some fitness training every day at the gym. This day, you are working out both for strength and aerobics as usual. You find there’s another guy wearing a glass-mounted camera today when you visit the gym.</td>
<td>You invite a group of friends to have dinner at your house with your family. You are cooking dinner and your kids are playing in the living room with your friends. When the pizza you ordered is delivered, you find that the driver is wearing a glass-mounted camera when delivering your food.</td>
<td></td>
</tr>
<tr>
<td><strong>Mid</strong></td>
<td>These days, you are dating a new man/woman. During the weekend, you two are taking a walk together down a busy street in your city and making plans. You find there’s another guy wearing a glass-mounted camera. The guy stands in the street corner and seemingly waits for someone else.</td>
<td>You are invited by a friend to attend a costume party. Therefore, you do your make-up and dress differently than in your daily life. Since there are only a few people who you know at the party, you have to dance and talk with strangers. In the crowd, you see another guest wearing a glass-mounted camera and moving around the party hall.</td>
<td>You go to the bank today. A friend goes to the bank with you. You two are discussing some plans about how to increase your families’ finances. You notice that there’s another customer sitting behind you is playing with a new glass-mounted camera while waiting in the line.</td>
<td></td>
</tr>
<tr>
<td><strong>High</strong></td>
<td>Today is your birthday. You decide to buy two bottles of wine to celebrate with your family. When paying at the checkout, you are required to show your ID card and pay by credit card. As you bring your cards out of your pocket, you see another customer in line behind you with a glass-mounted camera.</td>
<td>You work as an engineer at a giant IT company. Most of your work is confidential due to company policy. Today, you are working at your desk as usual. You just noticed that a visitor to your office is wearing a glass-mounted camera when walking around the office and talking with others.</td>
<td>This morning, you went by yourself to the hospital. Your main goal is to take an annual health exam. After finishing all of the tests, you are sitting in line and discussing some your health issues with a nurse in the lobby area. You see another patient in line wearing a glass-mounted camera that you have only seen in videos.</td>
<td></td>
</tr>
</tbody>
</table>
Survey Preview

Survey Structure

We used Qualtrics platform to implement and deliver the online questionnaire. At the beginning of the survey, the participants reviewed a consent form and agreed to it before starting answer the questions. Because wearable cameras have not become a common technology yet, we gave a brief introduction about basic functionality of this device in case some participants are not familiar with it.

<table>
<thead>
<tr>
<th>Technology Usage and Exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experience of computer, Internet, Smartphone</td>
</tr>
<tr>
<td>Experience of wearable devices</td>
</tr>
<tr>
<td>Knowledge of wearable cameras</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scenario-Based Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perception of wearable cameras</td>
</tr>
<tr>
<td>Reaction to recording</td>
</tr>
<tr>
<td>Ways of reaction</td>
</tr>
<tr>
<td>Concern for various type of information</td>
</tr>
<tr>
<td>Concern for information control and practices</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>General Attitude Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>General attitude to wearable cameras</td>
</tr>
<tr>
<td>Use the device for assist and safety</td>
</tr>
<tr>
<td>Comparison with existing recording technology</td>
</tr>
<tr>
<td>Beliefs and values</td>
</tr>
<tr>
<td>Rank privacy concerns about nine scenarios</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Demographic Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experience and media exposure of privacy invasion</td>
</tr>
<tr>
<td>Gender, Age, Education, Income</td>
</tr>
</tbody>
</table>

7 - Multiple Choice Question
5 - Likert Scale Question

Figure 5-1 Survey Structure
We demonstrate the structure of the survey in Figure 5-1. (The whole questionnaire can be found in Appendix E) At the beginning of the survey, we present questions about technology usage and experience of wearable technology. These question should not affect their answers to the following parts, and will evoke their ideas about wearable technology before they enter scenario-based questions.

As introduced above, we designed nine scenarios to provide a context for judgments about privacy intrusion. In order to reduce the length of the survey, we used a mixed between- and within-subject design, assigning three scenarios to each participants randomly. They then answered five questions for each given scenario. After the scenario-specific questions, all of the participants finish the remaining two parts of the survey shown in the figure. To minimize the impact of other scenarios on their perceptions, we asked them to rank general privacy concerns for all of the scenarios at the end of the general attitude part. Finally, they answered the demographic questions. All of the questions were in either multiple choice or Likert Scale format. Figure 5-2 shows an example of Likert Scale question.

We inserted two sets of attention filter questions in order to filter out the unqualified answers from the results. The first set includes questions that ask the participants to choose corresponding answers in the Likert Scale matrix. The second set is askd them some logical questions in contrapositive format. People who wrongly answered more than one of these questions would have been filtered out from our results. Fortunately, none of the participants were removed due to lack of attention to the filter questions.
Figure 5-2 Sample Likert Scale Item in the Survey

We recruited 400 participants from Amazon Mechanical Turk and set the criteria to only involve participants from the United States. The average time for finishing the survey was 18 minutes and they received 80 cents as compensation if they completed the entire survey.

Therefore, we got survey results from 400 valid participants for further analysis.

Data Analysis Method

For the survey questions, we recoded and categorized some of the options for sake of convenience in data analysis. In general, we have categorical data as answers for multiple choice questions and ordinal data for Likert Scale questions and for some of the covariates. Because we different subjects were randomly presented a different set of three scenario contexts, the data cannot be paired across these questions. We would like to explore the difference of distribution of their concerns and agreements on each Likert Scale item. Meanwhile, we plan to investigate the association between general attitude and reasons, as well as the association and correlation between their perceptions and covariates. Therefore, we take the following method for data analysis (Conover, 1999; Sheskin, 2000):

- Kruskal-Wallis test with post-hoc comparisons: a rank-based non-parametric test for distribution of ordinal dependent variable, e.g. concerns about various types of information in each scenario;
• Friedman test with pairwise comparisons: a non-parametric alternative to repeated measures ANOVA for distribution of related groups, e.g. reasons for why using wearable cameras as assistive technology is more acceptable;

• Chi-Square test: for distribution of cases in a single categorical variable, e.g. whether people hold different general attitude perceive each issue of using wearable cameras differently; and

• Spearman’s correlation: to find whether there is relationship between two ordinal variables, e.g. whether their concern for each type of information correlates with their age group.

We examined the following questions:

• *Whether participants have different level of concern on various type of private information and how the information would be used on the camera user within a specific scenario.*

• *Whether participants’ perceived privacy concerns are different among various scenarios.*

• *Whether participants’ perceived privacy concerns are correlated with covariates such as gender, age, income, media exposure and so on.*

**Demographic Information**

We recruited 400 on Amazon’s Mechanical Turk as survey participants. Their demographic information is presented in Table 5-4.
<table>
<thead>
<tr>
<th>Information</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>44.3%</td>
</tr>
<tr>
<td>Female</td>
<td>55.8%</td>
</tr>
<tr>
<td><strong>Age Group</strong></td>
<td></td>
</tr>
<tr>
<td>18-24</td>
<td>18.1%</td>
</tr>
<tr>
<td>25-34</td>
<td>43.5%</td>
</tr>
<tr>
<td>35-44</td>
<td>20.0%</td>
</tr>
<tr>
<td>45-54</td>
<td>12.3%</td>
</tr>
<tr>
<td>55-64</td>
<td>5.8%</td>
</tr>
<tr>
<td>65 and over</td>
<td>0.5%</td>
</tr>
<tr>
<td><strong>Income</strong></td>
<td></td>
</tr>
<tr>
<td>$0 - $25,000</td>
<td>28.7%</td>
</tr>
<tr>
<td>$25,001 - $50,000</td>
<td>31.5%</td>
</tr>
<tr>
<td>$50,001 - $75,000</td>
<td>18.0%</td>
</tr>
<tr>
<td>$75,001 - $100,000</td>
<td>11.5%</td>
</tr>
<tr>
<td>$100,001 - $150,000</td>
<td>7.5%</td>
</tr>
<tr>
<td>$150,001 - $200,000</td>
<td>1.8%</td>
</tr>
<tr>
<td>$200,001+</td>
<td>1.0%</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
</tr>
<tr>
<td>Less than High School</td>
<td>0.8%</td>
</tr>
<tr>
<td>High School / GED</td>
<td>10.5%</td>
</tr>
<tr>
<td>Some College</td>
<td>30.5%</td>
</tr>
<tr>
<td>2-year College Degree</td>
<td>12.3%</td>
</tr>
<tr>
<td>4-year College Degree</td>
<td>31.3%</td>
</tr>
<tr>
<td>Masters Degree</td>
<td>12.8%</td>
</tr>
<tr>
<td>Doctoral Degree</td>
<td>0.5%</td>
</tr>
<tr>
<td>Other Degree (JD, MD)</td>
<td>1.5%</td>
</tr>
<tr>
<td><strong>Experience of Privacy Invasion</strong></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>36.8%</td>
</tr>
<tr>
<td>No</td>
<td>64.2%</td>
</tr>
<tr>
<td><strong>Know Privacy Invasion News</strong></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>84.3%</td>
</tr>
<tr>
<td>No</td>
<td>15.7%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Information</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Computer Use History</strong></td>
<td></td>
</tr>
<tr>
<td>&lt;1 year</td>
<td>0.5%</td>
</tr>
<tr>
<td>1-2 years</td>
<td>1.0%</td>
</tr>
<tr>
<td>3-5 years</td>
<td>3.3%</td>
</tr>
<tr>
<td>6-10 years</td>
<td>9.8%</td>
</tr>
<tr>
<td>&gt;10 years</td>
<td>85.5%</td>
</tr>
<tr>
<td><strong>Internet Use History</strong></td>
<td></td>
</tr>
<tr>
<td>1-2 years</td>
<td>1.0%</td>
</tr>
<tr>
<td>3-5 years</td>
<td>2.0%</td>
</tr>
<tr>
<td>6-10 years</td>
<td>14.0%</td>
</tr>
<tr>
<td>&gt;10 years</td>
<td>83.0%</td>
</tr>
<tr>
<td><strong>Smart Phone Use History</strong></td>
<td></td>
</tr>
<tr>
<td>&lt;1 year</td>
<td>5.3%</td>
</tr>
<tr>
<td>1-2 years</td>
<td>8.5%</td>
</tr>
<tr>
<td>3-5 years</td>
<td>36.0%</td>
</tr>
<tr>
<td>6-10 years</td>
<td>44.0%</td>
</tr>
<tr>
<td>&gt;10 years</td>
<td>6.3%</td>
</tr>
<tr>
<td><strong>Use of Wearable Device</strong></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>56%</td>
</tr>
<tr>
<td>No</td>
<td>44%</td>
</tr>
<tr>
<td><strong>Know Wearable Camera</strong></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>81.5%</td>
</tr>
<tr>
<td>No</td>
<td>18.5%</td>
</tr>
<tr>
<td><strong>Know Google Glass</strong></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>83.5%</td>
</tr>
<tr>
<td>No</td>
<td>16.5%</td>
</tr>
</tbody>
</table>
Privacy Concerns within Scenarios

Perception and Reaction

At the beginning of each scenario, we asked participants about their concerns for other people using a wearable camera in the scenario; we framed this under the conditions of whether they are being recorded or not, and whether they know the user’s operation. We present the distribution of their perceptions in each scenario in Table 5-5 (percentage shown in Appendix A).

Perception

The Chi-square test of independence is calculated comparing the frequency of different ideas on wearable cameras in various scenarios. We find a significant association $\chi^2(40) = 18.94, p < .0005$. However, since we have a large sample ($N=400$), we do not trust the significance in Chi-square test directly. We test the adjusted residual of distribution in each scenario separately. By ignoring the choice “I have no ideas”, in the scenarios of travelling, dating and costume party, the percentage of “I don’t mind even being recorded” is significantly high (with adjusted residual larger than 2). In banking, office and hospital scenarios it has significantly low percentage (adjusted residual less than -2). On the other side, the percentage of “I can’t accept whether being recorded or not” is significantly low for travelling, dating and costume party while it is significantly high in the bank, office and hospital scenarios.

The scenarios of travelling, dating and costume party have a perceived low level of privacy concern. Meanwhile, bank, office and hospital have perceived high level of privacy concern. The other scenarios including fitness, home party and shopping are more neutral while shopping has a higher level than fitness and home party since the percentage of “I can’t accept if I
know being recorded” is significantly high. Therefore, the result conforms with the rationale of how we designed these scenarios and helps to validate the privacy level of each scenario.

Table 5-5 Distribution of Participants’ Perception in Each Scenario

<table>
<thead>
<tr>
<th>Travel</th>
<th>Fitness</th>
<th>Home Party</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dating</th>
<th>Costume Party</th>
<th>Bank</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shopping</th>
<th>Office</th>
<th>Hospital</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Reaction**

At the same time, we examine how the participants as observers would react to others using a wearable camera in each scenario. The distribution is summarized in Table 5-6 and the percentage is shown in Appendix A.

We also compared the frequency of different reaction between various scenarios. A significant association is found $\chi^2(40) = 11.65, p < .0005$. Also, we tested the adjusted residual of distribution in each scenario separately. Findings show that in the scenarios of travelling, home party and dating, the percentage of “I will act normally anyhow” is significantly high, while in banking, shopping and hospital scenarios it has significantly low percentage of a marginally significantly high in the office scenario. In contrast, the percentage of “I will act normally
“anyhow” is significantly low for travelling and dating, and is marginally high in the costume party scenario. At the same time, it is significantly high in the bank, shopping and office scenarios.

Table 5-6 Distribution of Participants’ Potential Reaction in Each Scenario

<table>
<thead>
<tr>
<th>Travel</th>
<th>Fitness</th>
<th>Home Party</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dating</th>
<th>Costume Party</th>
<th>Bank</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shopping</th>
<th>Office</th>
<th>Hospital</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As a whole, the average percentage of “it depends on whether the user is recording” ideas is 39.5%, which is the highest among the three choices. The result shows that whether the user is recording or not would be an important factor affecting the observers’ perceptions and reactions.

**Ways of Reacting**

From the content analysis of focus group interview, we had generated three statements of how the observer might react when someone else was using a wearable camera. When participants chose “It depends” or “I will act differently anyhow,” they were also asked to evaluate these three statements on a five-point Likert scale from strongly agree (5) to disagree.
strongly (5). Table 5-7 summarizes the number of participants who answered this question in each scenario. Because the Likert scale data is non-parametric, we used the Friedman test to examine whether there is a significant difference between three statements in each scenario. As a whole, the participants have significant higher agreements on “I will be more careful about what I say” and lower agreements on “I will ask the user to stop using the device”. We further examined their agreements on each statement respectively.

Table 5-7 Number of Participants Answering Detailed Reaction Questions

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Travel</th>
<th>Fitness</th>
<th>Home Party</th>
</tr>
</thead>
<tbody>
<tr>
<td>N=61/137</td>
<td>N=97/134</td>
<td>N=80/133</td>
<td></td>
</tr>
<tr>
<td>(44.5%)</td>
<td>(72.4%)</td>
<td>(60.2%)</td>
<td></td>
</tr>
<tr>
<td>Dating</td>
<td>Costume Party</td>
<td>Bank</td>
<td></td>
</tr>
<tr>
<td>N=83/138</td>
<td>N=83/132</td>
<td>N=106/135</td>
<td></td>
</tr>
<tr>
<td>(60.1%)</td>
<td>(62.9%)</td>
<td>(78.5%)</td>
<td></td>
</tr>
<tr>
<td>Shopping</td>
<td>Office</td>
<td>Hospital</td>
<td></td>
</tr>
<tr>
<td>N=105/132</td>
<td>N=101/135</td>
<td>N=102/133</td>
<td></td>
</tr>
<tr>
<td>(79.5%)</td>
<td>(74.8%)</td>
<td>(76.7%)</td>
<td></td>
</tr>
</tbody>
</table>

Figure 5-3 Pairwise comparisons of scenarios - Reaction 1
A Kruskal-Wallis test was conducted to determine if there are differences in the participants’ opinions on the statement “I will be more careful about what I say, how I act and so on.” between the nine different scenarios. Distribution of their agreement on the statement is not similar for all the scenarios, as assessed by visual inspection of a bar chart. Agreements are statistically significantly different between the various scenarios, $\chi^2(8) = 29.46, p < .0005$. Subsequently, pairwise comparisons are performed using Dunn’s (1964) procedure with a Bonferroni correction for multiple comparisons. This post hoc analysis revealed a statistically significant difference in the participants’ agreement on this statement between travelling (343.68) and bank (452.49) scenarios ($p = .04$), travelling (343.68) and office (460.34) ($p = .019$), costume party (355.12) and bank (452.49) ($p = .049$), and costume party (355.12) and office (460.34) ($p = .022$). Meanwhile, the dating scenario (363.54) is marginally significantly different with the office (460.34) ($p = .059$). However, there is no significant difference between any other group combination.

Figure 5-4 Pairwise comparisons of scenarios - Reaction 2
A Kruskal-Wallis test is conducted to determine if there were differences in the participants’ opinions on the statement “I will leave the place where it is possible to be recorded by the user either intentionally or by accident” between nine different scenarios. Distribution of their agreement on the statement is not similar for all the scenarios, as assessed by visual inspection of a bar chart. Agreements are statistically significantly different between the different scenarios, \(\chi^2(8) = 42.08, p < .0005\). The post hoc analysis reveals statistically significant differences in the participants’ agreement on this statement when comparing home party (285.79) with fitness (473.00) \((p < .0005)\), dating (422.26) \((p = .004)\), bank (401.01) \((p = .02)\), shopping (414.77) \((p = .004)\), office (409.85) \((p = .009)\) and hospital (460.89) \((p < .0005)\). The results also show a marginally difference between fitness (473.00) and costume party (369.37) \((p = .076)\), and between dating (422.26) with office (409.85) \((p < .059)\) However, there is no significant difference between any other group combinations.

Lastly, we examined agreement to the statement “I will ask the user to remove the camera and not to record me by using it” between nine different scenarios. Distribution of their agreement on the statement is not similar for all the scenarios, as assessed by visual inspection of a bar chart. Agreements are statistically significantly different between different scenarios, \(\chi^2(8) = 63.626, p < .0005\). The post hoc analysis revealed statistically significant difference in the participants’ agreement on this statement when comparing travelling (286.22) with home party (486.42) \((p < .0005)\), bank (409.75) \((p = .03)\), shopping (407.65) \((p = .037)\), office (501.26) \((p < .0005)\) and hospital (435.31) \((p = .002)\). There also shows significant different between office (501.26) and fitness (382.86) \((p = .032)\), dating (357.03) \((p = .001)\) and costume party (311.49) \((p < .0005)\). In addition, the distribution in home party (486.42) scenario is significantly different with in dating (357.03) \((p = .012)\) and costume party (311.49) \((p < .0005)\). Finally, significant difference also exists between costume party (311.49) scenario with hospital (435.31) \((p = .009)\). There is no significant difference between any other group combination.
Figure 5-5 Pairwise comparisons of scenarios - Reaction 3

**Rank of Scenarios**

At the end of the survey, we asked the participants to evaluate the level of their perceived privacy in each scenario that we used in the scenario-based questions. In this question, we used a 7-point Likert scale to have more distinguished ranks of these scenarios. In previous studies about risk perception for smart phones and wearable devices, researchers used a 5-point Likert scale from “indifferent” to “very upset” and set a metric to measure the percentage of “very upset” respondents instead of using medians called VUR (Felt et al., 2012; Lee, 2015). Because our responses are not normally distributed either, and the medians were shown in a very similar ranking, we made use of this metric to compare the observers’ privacy concern for the types of information against each other rather than to measure the absolute concern. Therefore, we use MCR to refer to the percentage of “most concern” responses in this case.
Table 5-8 MCR and Answer Distribution in Each Scenario

<table>
<thead>
<tr>
<th></th>
<th>Travel 8.8%</th>
<th>Fitness 15.8%</th>
<th>Home Party 15.5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dating 13.0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Costume Party 9.3%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bank 27.8%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shopping 28.7%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Office 57.3%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital 38.5%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The Friedman test indicates that their level of concern in each scenario is significantly different, \( \chi^2(8) = 829.449, p < .0005 \). In the Pairwise Comparisons, we find that these scenarios can be separated into four groups. The first one is the “least concern” group, which includes travelling and costume party scenarios; these are significantly lower than other groups. The second group is the “medium concern” group, and is comprised of fitness, home party and dating scenarios. Bank, shopping and hospital formed the “high concern” scenario grouping. Finally, the confidential-work office scenario evoked the observers’ highest level of concern and was significantly higher than any other group.

This result mainly accords with our scenario design and data analysis of types of information and types of concern questions. A slight difference exists between office and hospital scenarios. Although the participants show the highest level of concern about various kinds of information in the hospital scenarios, they perceive the office scenario to have the highest level of privacy concern when we described these scenarios in the same question. Because this scenario
may involve valuable and confidential information relevant to the company (rather than personal information only), we think it should be carefully studied in future.

**Concern about Type of Private Information**

We selected eight types of information involved in the observers’ daily lives including personal characteristics, images and videos, current action, current communication, current emotion and facial expression, association and companions, current location and financial information. Then we asked the participants to evaluate their privacy concerns on each type of the information in a particular scenario by using a 5-point Likert scale (most concern to least concern). We again used the Most Concern Rate (MCR) to contrast the participants’ differing levels of concern for different types of information.

Table 5-9 Most Concern Respond Rate (MCR) for 8 Type of Information in 9 Scenarios

<table>
<thead>
<tr>
<th></th>
<th>travel</th>
<th>fitness</th>
<th>home party</th>
<th>dating</th>
<th>costume party</th>
<th>bank</th>
<th>shopping</th>
<th>office</th>
<th>hospital</th>
<th>Kruskal-Wallis (p value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>personal information</td>
<td>21.00%</td>
<td>30.20%</td>
<td>26.80%</td>
<td>24.40%</td>
<td>19.80%</td>
<td>28.00%</td>
<td>24.00%</td>
<td>34.60%</td>
<td>35.90%</td>
<td>.006</td>
</tr>
<tr>
<td>images and videos</td>
<td>13.70%</td>
<td>30.50%</td>
<td>23.60%</td>
<td>14.90%</td>
<td>19.80%</td>
<td>22.20%</td>
<td>22.50%</td>
<td>34.10%</td>
<td>28.60%</td>
<td>.001</td>
</tr>
<tr>
<td>action</td>
<td>20.50%</td>
<td>34.90%</td>
<td>24.80%</td>
<td>23.50%</td>
<td>24.20%</td>
<td>38.30%</td>
<td>30.50%</td>
<td>41.70%</td>
<td>43.10%</td>
<td>&lt;.0005</td>
</tr>
<tr>
<td>Communication</td>
<td>23.70%</td>
<td>30.80%</td>
<td>26.90%</td>
<td>26.30%</td>
<td>25.60%</td>
<td>45.00%</td>
<td>28.10%</td>
<td>47.70%</td>
<td>51.10%</td>
<td>&lt;.0005</td>
</tr>
<tr>
<td>Emotion/ facial express</td>
<td>19.50%</td>
<td>27.50%</td>
<td>22.22%</td>
<td>25.50%</td>
<td>20.50%</td>
<td>24.10%</td>
<td>20.90%</td>
<td>31.50%</td>
<td>38.80%</td>
<td>.009</td>
</tr>
<tr>
<td>association and companion</td>
<td>15.20%</td>
<td>25.60%</td>
<td>27.50%</td>
<td>25.00%</td>
<td>14.80%</td>
<td>25.80%</td>
<td>25.80%</td>
<td>35.30%</td>
<td>40.00%</td>
<td>.001</td>
</tr>
<tr>
<td>location</td>
<td>24.10%</td>
<td>35.40%</td>
<td>38.60%</td>
<td>30.10%</td>
<td>27.90%</td>
<td>45.10%</td>
<td>34.90%</td>
<td>42.90%</td>
<td>50.00%</td>
<td>.0005</td>
</tr>
<tr>
<td>financial information</td>
<td>42.30%</td>
<td>44.00%</td>
<td>46.20%</td>
<td>37.70%</td>
<td>37.20%</td>
<td>77.90%</td>
<td>71.70%</td>
<td>56.60%</td>
<td>51.60%</td>
<td>.0005</td>
</tr>
<tr>
<td>Friedman Test (p value)</td>
<td>&lt;.0005</td>
<td>.010</td>
<td>&lt;.0005</td>
<td>&lt;.0005</td>
<td>&lt;.0005</td>
<td>&lt;.0005</td>
<td>&lt;.0005</td>
<td>&lt;.0005</td>
<td>&lt;.0005</td>
<td>.0005</td>
</tr>
</tbody>
</table>
In each specific scenario, we tested whether there is a different level of privacy concern for each type of information, using the Friedman Test. We found that observers’ concerns show statistically significant differences in all of the scenarios with $\chi^2(7) = 42.691, p < .0005$ in travelling, $\chi^2(7) = 18.515, p = .010$ in fitness, $\chi^2(7) = 99.786, p < .0005$ in home party, $\chi^2(7) = 43.098, p < .0005$ in dating, $\chi^2(7) = 27.793, p < .0005$ in costume party, $\chi^2(7) = 157.87, p < .0005$ in bank, $\chi^2(7) = 145.456, p < .0005$ in shopping, $\chi^2(7) = 45.563, p < .0005$ in office and $\chi^2(7) = 57.338, p < .0005$ in hospital.

Meanwhile, we used the Kruskal-Wallis test to examine whether the observers have different concern for the same type of information in different scenarios. Distribution of their privacy concern is not similar for all the scenarios, as assessed by visual inspection of a bar chart. Agreements are statistically significantly different between different scenarios for each type of information with $\chi^2(8) = 21.450, p = .006$ for personal information, $\chi^2(8) = 27.360, p = .001$ for images and videos, $\chi^2(8) = 47.130, p < .0005$ for current action, $\chi^2(8) = 56.908, p < .0005$ for current communication, $\chi^2(8) = 20.425, p = .009$ for emotion and facial expression, $\chi^2(8) = 27.036, p = .001$ for association and companion, $\chi^2(8) = 48.462, p < .005$ for location and $\chi^2(8) = 86.789, p < .0005$ for financial information. Since we use MCR (most concern rate) to compare privacy concern among various types of information, we do not report the post hoc results for Friedman test and Kruskal-Wallis test here. Instead, we list the MCR for each type of information in each scenario in Table 5-9. The cell with higher MCR means the participants show greater privacy concern about this type of information in this scenario. For example, their concerns about financial information in the bank scenario are greater than in other scenarios.
Moreover, we also apply one-way repeated measures ANOVA to test whether there is a significant difference of overall privacy concerns for each type of information by using MCR. The result indicates that the privacy concern for each kind of information is significantly different with $F(1.861, 14.890) = 22.622, p < .0005$. (Means shown in Figure 5-5) In the post hoc test, we find that concern for financial information is significantly higher than other kinds of information. Concerns about current actions, communication and location are lower than financial information, but a little higher than others. And images, emotion and association evoke the least concerns for all types of information.

**Information Control and Practice**

We also concluded ten issues of the observers’ concern about how their information will be processed and used the user as follows:

- *Without control for whether information is collected.*
• **Without control for which information is collected.**
• **Don’t know the person who’s recording me.**
• **Information might be reused and modified by the user.**
• **Information might be reused and modified by the others.**
• **Information might be accessed by a third-party person or organization.**
• **Information would be wrongly interpreted after recording.**
• **Information would be used as an element of a whole database.**
• **Information would be posted to public network such as social medias.**
• **Information would bring real-life risk to my daily life.**

We asked the participants to evaluate each concern in a specific scenario by using a 5-point Likert scale (most concern to least concern). As we did when analyzing types of information, we used MCR to refer to the percentage of “most concern” responses. In each specific scenario, we conducted a Friedman test to determine whether there are differences between each concern. We find the observers’ concerns show statistically significant differences in all of the scenarios with with $\chi^2(9) = 38.044, p < .0005$ in travelling, $\chi^2(9) = 61.071, p < .0005$ in fitness, $\chi^2(9) = 56.639, p < .0005$ in home party, $\chi^2(9) = 58.202, p < .0005$ in dating, $\chi^2(9) = 66.798, p < .0005$ in costume party, $\chi^2(9) = 59.311, p < .0005$ in bank, $\chi^2(9) = 27.740, p = .001$ in shopping, $\chi^2(9) = 47.856, p < .0005$ in office and $\chi^2(9) = 58.426, p < .0005$ in hospital.

Meanwhile, we examine whether the observers’ ideas are different for the same concern in various scenarios. Distribution of their privacy concern is not similar for all the scenarios, as assessed by visual inspection of a bar chart. Their perceptions are statistically significantly different between different scenarios for each issue with $\chi^2(8) = 62.475, p < .0005$ for “whether the information will be collected”, $\chi^2(8) = 64.118, p < .0005$ for “who will collect the information”, $\chi^2(8) = 25.490, p = .001$ for “don’t know the user”, $\chi^2(8) = 45.123, p < .0005$ for
“Information will be reused and modified by the user”, $\chi^2(8) = 55.887, p < .0005$ for

“Information will be reused or modified by others”, $\chi^2(8) = 67.549, p < .0005$ for “Information will be accessed by third parity”, $\chi^2(8) = 26.643, p = .001$ for “Information will be wrongly interpreted”, $\chi^2(8) = 58.606, p < .0005$ for “Information will be used in a database” , $\chi^2(8) = 22.3456, p = .004$ for “Information will be posted to public network” and , $\chi^2(8) = 36.049, p < .0005$ for “Information recorded will be bring real-life risks”. Since we use MCR (most concern rate) to compare their concerns about information control and practice, we do not report the post hoc results for Friedman test and Kruskal-Wallis test here. Instead, we list the MCR for each concern in various scenarios in Table 5-10.

Table 5-10 MCR for Concerns about Information Control and Practice

<table>
<thead>
<tr>
<th>Concerns about Information Control and Practice</th>
<th>travel</th>
<th>fitness</th>
<th>home party</th>
<th>dating</th>
<th>costume party</th>
<th>bank</th>
<th>shopping</th>
<th>office</th>
<th>hospital</th>
<th>Kruskal-Wallis (p value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whether information is collected</td>
<td>34.1%</td>
<td>57.3%</td>
<td>54.2%</td>
<td>48.2%</td>
<td>39.2%</td>
<td>61.8%</td>
<td>61.1%</td>
<td>67.2%</td>
<td>60.6%</td>
<td>&lt;.0005</td>
</tr>
<tr>
<td>Who collect the information</td>
<td>34.3%</td>
<td>57.7%</td>
<td>54.2%</td>
<td>44.5%</td>
<td>40.0%</td>
<td>61.8%</td>
<td>61.1%</td>
<td>67.2%</td>
<td>62.1%</td>
<td>&lt;.0005</td>
</tr>
<tr>
<td>Don’t know the user</td>
<td>44.4%</td>
<td>58.8%</td>
<td>56.9%</td>
<td>51.1%</td>
<td>43.8%</td>
<td>59.1%</td>
<td>60.3%</td>
<td>57.1%</td>
<td>54.5%</td>
<td>.001</td>
</tr>
<tr>
<td>Information will be modified by user</td>
<td>37.3%</td>
<td>58.8%</td>
<td>53.8%</td>
<td>46.7%</td>
<td>39.5%</td>
<td>59.8%</td>
<td>61.5%</td>
<td>59.7%</td>
<td>60.3%</td>
<td>&lt;.0005</td>
</tr>
<tr>
<td>Information will be modified by others</td>
<td>32.8%</td>
<td>54.2%</td>
<td>48.5%</td>
<td>42.3%</td>
<td>39.2%</td>
<td>60.6%</td>
<td>61.6%</td>
<td>59.7%</td>
<td>59.1%</td>
<td>&lt;.0005</td>
</tr>
<tr>
<td>Information will be accessed by third party</td>
<td>35.6%</td>
<td>57.3%</td>
<td>50.8%</td>
<td>39.4%</td>
<td>33.8%</td>
<td>59.4%</td>
<td>60.3%</td>
<td>63.4%</td>
<td>55.0%</td>
<td>&lt;.0005</td>
</tr>
<tr>
<td>Information will be wrongly interpreted</td>
<td>31.9%</td>
<td>51.9%</td>
<td>43.9%</td>
<td>45.3%</td>
<td>38.5%</td>
<td>45.1%</td>
<td>52.8%</td>
<td>53.0%</td>
<td>51.9%</td>
<td>.001</td>
</tr>
<tr>
<td>Information will be used in a database</td>
<td>26.9%</td>
<td>44.3%</td>
<td>38.9%</td>
<td>29.4%</td>
<td>23.8%</td>
<td>50.4%</td>
<td>48.1%</td>
<td>50.7%</td>
<td>43.9%</td>
<td>&lt;.0005</td>
</tr>
<tr>
<td>Information will be posted to public network</td>
<td>39.6%</td>
<td>60.6%</td>
<td>50.0%</td>
<td>43.8%</td>
<td>45.4%</td>
<td>53.0%</td>
<td>56.6%</td>
<td>55.2%</td>
<td>54.5%</td>
<td>.004</td>
</tr>
<tr>
<td>Information recorded will bring real-life risk</td>
<td>32.6%</td>
<td>44.9%</td>
<td>42.0%</td>
<td>39.0%</td>
<td>31.7%</td>
<td>48.9%</td>
<td>43.6%</td>
<td>50.4%</td>
<td>42.0%</td>
<td>&lt;.0005</td>
</tr>
<tr>
<td>Friedman test (p value)</td>
<td>&lt;.0005</td>
<td>&lt;.0005</td>
<td>&lt;.0005</td>
<td>&lt;.0005</td>
<td>&lt;.0005</td>
<td>&lt;.0005</td>
<td>&lt;.0005</td>
<td>&lt;.0005</td>
<td>&lt;.0005</td>
<td>&lt;.0005</td>
</tr>
</tbody>
</table>

We tested the participants’ overall concerns about each issue by using MCR. The result shows that the overall level of each dimension of concern is significantly different with $F(2.503, 20.022) = 22.348, p < .0005$. We observed the post hoc analysis of each issue and found
that concern about “integrate information to a whole database” and concern about “information recorded would bring real-life risk” are significantly lower than other issues. On the other side, concern for “whether information is collected”, “which information is collected”, “don’t know the user” and “information will be modified by the user” rank higher than other dimensions, but no significance is found in the pairwise comparison between them.

Figure 5-7 MCR Mean for Ten Issues about Information Control and Practice

**General Attitude**

We asked the participants about their general attitude about glass-mounted wearable cameras as an observer, and provided four choices. Among all of the participants (N=400), 74% of them (N=297) hold the opinion that “As an observer, I can accept use of the device but I have some concerns”, while 12% of them (N=47) choose not to accept use of the device and still have some concerns. (shown in figure 5-1) Meanwhile, we listed 13 reasons for their attitude towards
wearable cameras, and asked the participants to evaluate these reasons using a 5-point Likert scale from strongly agree to strongly disagree.

1. People are legal to record in public spaces.
2. People are already legal to record by other devices.
3. I'm not important enough to be recorded as a normal person.
4. Use of the device is a trend in future and observers’ attitude will progress with time.
5. Personally, I'm very tech savvy and interested in new products.
6. If there's only one person using it around me, it will be weird.
7. If there are many people using it around me, it will be okay.
8. Recording in public spaces may invade others privacy.
9. Recording by glass-style wearable camera is threatening because it's hidden.
10. It's risky to be probably recorded anywhere and any time.
11. It's risky to be recorded by someone unknown.
12. There's no necessity to use this device.
13. Personally, I would not like anyone to record me.

Figure 5-8 General Attitude towards Wearable Cameras
We used a Friedman test to compare whether there is a difference between their agreements on each reason. The observers’ concerns agreements are different on each statements with $\chi^2(12) = 483.528, p < .0005$. The distribution of their agreements on each reason is shown in Table 5-11.

Table 5-11 Distribution of the Observers' Agreements on Each Reason

<table>
<thead>
<tr>
<th>Agreements</th>
<th>Reason1</th>
<th>Reason2</th>
<th>Reason3</th>
<th>Reason4</th>
<th>Reason5</th>
<th>Reason6</th>
<th>Reason7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agreements</td>
<td>Reason8</td>
<td>Reason9</td>
<td>Reason10</td>
<td>Reason11</td>
<td>Reason12</td>
<td>Reason13</td>
<td></td>
</tr>
</tbody>
</table>

Figure 5-9 shows the pairwise comparison between their agreements on each reason. In details, their agreement on “It’s risky to be recorded by someone unknown.” ranks significantly highest among the 13 statements and followed by “Personally, I would not like anyone to record me.”, “Recording in public spaces may invade others privacy” and “It’s risky to be probably recorded anywhere and anytime”. On the other side, statement 7 “If there are many people using it around me, it will be okay” rank the lowest, while “I’m not important enough to be recorded as a normal person” rank a little higher than statement 7. Statement 4, 6 and 12 also rank significantly lower than most of the statements except for statement 7 and 3. We list the detailed pairwise comparison in Appendix A.

It is interesting to find that statement 3 “observers’ attitude will progress with time” and 7 “If there are many people using it around me, it will be okay” rank lowest among all statements. The participants express their ideas that the increase of wearable camera users will not affect their concern or increase their acceptance of this type of device significantly. Meanwhile, according to
the comments in the focus group interviews, the participants felt that “I’m not important enough to be recorded”; however the survey participants had a different response to this statement.

Figure 5-9 Pairwise Comparison of Agreements on the Reasons

Furthermore, we examine the association between their agreements on the statements and their general attitude and results. Among these 13 statements, there are six positive reasons and seven negative reasons. We find that participants who hold a general attitude as “accept the use of wearable cameras” generally show higher agreements on the positive statements and lower on the negative ones. In contrast, participants with “not accept” attitude have higher agreements on negative ones. Therefore, their detailed ideas conform with their general attitude.
Wearable Camera as Assistive Technology or Public Safety Device

We would like to explore if we use wearable cameras as personal assistive technology and public safety devices, whether the observers’ perceptions would change. Hence, we asked the participants to choose their general attitude on wearable cameras as personal assistive technology in terms of acceptance and concerns. In comparison with their general attitude on this type of device, they have higher acceptance under this circumstance. 39% of the participants (N=157) chose to accept without any concerns, and 53% (N=212) choose to accept in spite of having concerns. Only 8% (N=31) still could not accept the use of this type of device.

We also asked participants to evaluate their acceptance of wearable camera as a public safety device. Although the acceptance rate is still higher than general attitude with 28% (112) acceptance rate without concern, and 59% (236) acceptance rate with concern, it is lower than the case of using this device as assistive technology. Additionally, 9.75% (N=39) participants choose not to accept and have concerns, which is almost two times higher than as an assistive technology. It seems that people may show a deeper sympathy and empathy for others who need help than to the use of wearable cameras for public surveillance (though it may also seem less obvious how such a usage would occur).
Figure 5-10 Attitude on Wearable Cameras as Personal Assistive Technology

Figure 5-11 Attitude on Wearable Cameras as Public Safety Device

Under each circumstance, we also listed several statements adapted from focus group comments, asking the participants to evaluate each on a 5-point Likert scale. Here are the six statements of attitude when using wearable camera as a personal assistive technology:

1. It's always good to assist people by technology anyhow.
2. *It's good to assist people by technology as long as it doesn't affect invade other's privacy in public.*

3. *It can be used as long as being standardized.*

4. *It may be abused if there's no limitation.*

5. *There's no necessity to use camera function for assisting people.*

6. *There's no necessity to use this new device for assisting people.*

This set includes three statements (1-3) that support using this type of device for assistive purpose, and three (4-6) that convey a negative attitude. Overall, participants’ agreement with the negative statements were significantly lower than positive ones. The one they showed highest agreements on is was #2, which states that technology is good as long as it does not invade others’ privacy in public. By comparing with the statement of “It’s always good to assist people with technology anyhow”, the participants still have concerns although they have higher acceptance under this circumstance.

![Pairwise comparisons of reasons – use wearable camera for assist](image-url)
Meanwhile, they do express concerns about misuse of the technology. We tested to see if there is an association between their agreements on each statement and how they perceive wearable camera as assistive technology regarding acceptance and concern. We found is a significant association between their attitude on using wearable camera as assistive technology and their agreements on all of the six statements. The participants who show acceptance of this device tend to agree more on the positive statements (1-3), while participants who do not accept have higher agreements on negative ones (5-6). The pattern is unclear for “It may be abused if there’s no limitation”. We think it will be the general concern for the society since we get similar answers from our focus group interviews. The results of pairwise comparison is illustrated in Figure 5-12.

Similarly, we included 4 statements about using wearable camera as public safety device and asked the participants to evaluate their agreements on each one. The statements are shown as follows:

1. *It’s important and necessary to monitor for public good.*
2. *Public safety weighs against risk of privacy being invaded.*
3. *There's no necessity to use this device even if for public good.*
4. *There's no necessity to use this device because public cameras such as CCTVs have already worked for this purpose.*

According to the analysis, there is significant different on each statements with $\chi^2(3) = 145.036, p < .0005$. Post hoc analysis (illustrated in Figure 5-13) reveals that agreements on “It’s important to monitor for public good” was significantly higher than statement 2 ($p = .026$), statement 3 ($p < .0005$), and statement 4 ($p < .0005$), while their agreements on statement 2 rank second and significantly higher than statement 3 ($p < .0005$) and statement 4 ($p = .019$). Although they show higher agreements on positive reasons for using wearable cameras as public
safety device, we find the level of agreements on these reasons are significantly lower than positive reasons for using wearable cameras as personal assistive technology. The result indicates that these reasons are not strong enough to persuade them to accept the device as public safety camera without great concerns.

![Diagram](image)

Figure 5-13 Pairwise comparisons of reasons - wearable camera for public safety

Additionally, the participants have lowest agreements on statement 3, and statement 4 is significantly higher than it with \( p < .0005 \). There is also a significant association between their ideas about using wearable camera as public safety device with statement 1 \( (\chi^2(12) = 203.280, p < .0005) \), statement 2 \( (\chi^2(12) = 132.862, p < .0005) \), statement 3 \( (\chi^2(12) = 164.154, p < .0005) \) and statement 4 \( (\chi^2(12) = 108.280, p < .0005) \). People who have higher acceptance of using the device show higher agreements on positive statements (1-2), while people can not accept use of the device show higher agreement on negative ones (3-4). This results confirm that as reasons for their acceptance and concerns, their agreements on these statements conform with their attitude.
Comparison with Existing Image Capture Devices

We asked the participants to compare the perceived privacy concern for wearable cameras to smart phones and public safety cameras. They were asked to choose whether these devices evoked the same or different privacy concerns from an observer’s perspective. When comparing to smart phones, 75.8% (N=303) participants perceive that wearable cameras will bring more privacy concerns and 21.8% (N=87) think they are the same. Only 2.5% (N=10) participants consider smart phones will bring more privacy concerns. Similar result is shown in the case when comparing wearable cameras with public safety cameras. 75% (N=300) think wearable cameras will bring more privacy concerns, 19.3% (N=77) chose they are the same and only 5.7% (N=23) concern more about public safety cameras.

Figure 5-14 Perception of Privacy Concern for Wearable Cameras and Smart Phones

For each comparison, the question was followed by evaluation of 6 reasons for why the participants had such an idea. All the statements were generated from focus group interview. Participants were still asked to use 5-point Likert scale when evaluating the reasons.
Here are the listed reasons for comparing wearable cameras with smart phones:

1. *People are legal to record by wearable camera where they are legal to record by smart phone.*

2. *If a person would like to record you, they are easy to record by either smart phone or wearable camera.*

3. *Wearable cameras are hidden better, while smart phones are more visible.*

4. *You cannot tell whether a wearable camera is being operated, but it’s easy to tell whether a smart phone is recording.*

5. *Wearable cameras can keep recording, while smart phones can only record intentionally to specific area and point.*

6. *Almost everyone has smart phone, but only few people own wearable cameras.*

Figure 5-15 Perception of Privacy Concern for Wearable Cameras and Public Safety Cameras
The participants’ agreement with each reason is significantly different with $\chi^2(5) = 75.886, p < .0005$. In detail, the idea of “Wearable cameras are hidden better” received significantly higher agreements than reason 1 ($p < .0005$), reason 2 ($p < .0005$), reason 4 ($p = .002$), reason 5 ($p < .0005$), and reason 6 ($p = .047$). Meanwhile, their agreement with “Almost everyone has a smart phone, but only a few people own wearable cameras” is significantly higher than reason 1 ($p < .0005 = .019$) and marginally higher than reason 2 ($p = .092$). Additionally, reason 2 “People are easy to record you by either smart phone or wearable camera” ranks in the lower half among the six reasons. We conclude that the ease of recording by wearable camera and smart phone is different, although their functionalities are similar.

Here are the six ideas about comparing wearable cameras with public safety cameras.

1. **People are legal to record by wearable camera where they are legal to record by public cameras.**

2. **Wearable cameras are controlled by individual user, while public cameras are only controlled by trustworthy authorities.**

3. **Wearable cameras are hidden better, while public cameras are more visible.**
4. You cannot tell whether a wearable camera is being operated, but it's easy to tell that the public cameras are recording.

5. Wearable cameras can record anywhere, while public cameras are pointing to specific areas.

6. I know the purpose of public cameras, but I don't know the purpose of being recorded by wearable cameras.

Figure 5-17 Pairwise comparisons of reasons - compare with PSS

We examine whether there was difference of their agreements on each reasons, and the results indicated there was significant difference existed with $\chi^2(5) = 105.644, p < .0005$. The post hoc test showed that their agreement on ideas of “Wearable cameras can record anywhere” was significantly higher than reason 1 ($p < .0005$), reason 2 ($p < .0005$), reason 3 ($p = .017$), and reason 4 ($p < .0005$). Agreements on reason 6 “I don’t know the purpose of being recorded by wearable cameras” are also higher than reason 1 ($p = .001$), reason 2 ($p = .049$) and reason 4 ($p < .0005$). We think the main concerns for wearable camera when comparing with public safety
cameras is their portability and personal recording purpose instead of lack of trustworthy authority and invisibility.

In this section, we explored the difference of wearable cameras and existing recording technologies. The characteristics of wearable camera including ease of being hidden and portability added more privacy concerns for this new type of device. Meanwhile, as a new technology, people show higher privacy concern for unfamiliar products.

Belief and Value

Belief

We assessed 5 trusting beliefs and 4 risk beliefs relating to usage of wearable camera. In general, the definition of trusting belief is the degree to which people believe a firm or entity is dependable in protecting others’ personal information (Gefen et al., 2013; Malhotra, 2004); and risk belief is defined as the expectation of a high potential for loss associated with releasing personal information to the user (Dowling et al., 1994; Malhotra, 2004). In our study, trusting belief maps to the observers’ intention to trust the user while risk belief refers to their intention to not trust the user. We asked the participants to evaluate the 9 beliefs by a 5-scale Likert scale from strongly agree to strongly disagree which shown as follows:

1. The user will not record me intentionally.
2. The user will not record me by accident.
3. The user will not misuse my information if they accidentally record me.
4. The user will not distribute or post my information if they accidentally record me.
5. The user will know the boundary between public and private when recording.
6. *The user will record me intentionally.*

7. *The user will record me anywhere and any time.*

8. *The user will misuse my information.*

9. *The user will distribute my information*

Figure 5-18 Pairwise comparisons of beliefs

There is significant difference among their agreement with each belief with $\chi^2(8) = 218.324, p < .0005$. In the post hoc test, the participants showed significantly higher agreement about risk beliefs than trusting beliefs. There is also significant difference in the trusting belief group with $\chi^2(4) = 45.988, p < .0005$. Among the five trusting beliefs, their agreement on “The user will not record me intentionally” is significantly higher than belief 2 ($p < .0005$), belief 4 ($p = .027$) and belief 5 ($p = .002$). However, we do not find significance in difference of their agreements on risk beliefs, which indicates that they hold a high risk belief of using wearable cameras from various aspects.
We also test whether their privacy beliefs are associated with their general acceptance and concern of wearable cameras. Those who hold an opinion of accepting use of wearable cameras show higher agreements on trusting beliefs, while those who do not accept use of wearable cameras showed higher agreements on risk belief than the other group. This result suggests that the observers’ privacy concern may have a negative effect on trusting beliefs and a positive effect on risk belief; this conforms with the IUIPC model. (Malhotra, 2004)

Value

Finally, we test the participants’ perceived value of using wearable device. Value refers to how the observers think the user would use the wearable cameras. The following six values were generated from focus group interview and evaluated by the participants.

1. *The user should never record any strangers either intentionally or by accident.*
2. *The user should ask for consent before recording.*
3. *The user should not store or use my information if recorded accidentally.*
4. *The user should know the boundary between public and private when recording.*
5. *The user should comply with the policy of recording.*
6. *The user should not use a wearable camera.*

There is significant difference in their ideas on each value with $\chi^2(5) = 646.447, p < .0005$. Among six values of how to use wearable cameras, their agreement on “The user should not use a wearable camera” is significantly lower than value 2 ($p < .0005$), value 3 ($p < .0005$), value 4 ($p < .0005$) and value 5 ($p < .0005$). Meanwhile, their agreement on “The user should never record any strangers either intentionally or by accident” is lower than value 2 ($p < .0005$), value 3 ($p < .0005$), value 4 ($p < .0005$) and value 5 ($p < .0005$). We do not find significance in other pairs.
Figure 5-19 Pairwise comparisons of values

Significance also exists in the association of their ideas on each value with their general perception of wearable cameras. People who can accept the use of wearable cameras have lower agreements on these values than people who can not accept it. Since all of the six values we tested were neutral or negative, this result is consistent with our previous findings.

In summary, the participants agree to the use of wearable cameras in future, which can also be inferred from the percentage of users who show acceptance in general perception question. Meanwhile, although asking for consent was mentioned in the focus group interview, the survey results indicate it is not applicable in real scenarios of using wearable cameras. They perceive that from one side, relevant policies and regulations should be published as the device emerging in the market. On the other hand, users should be careful with their recording action and avoid recording anything that will possibly invade the privacy of others. Although it is difficult to build trust between stranger users and observers, the observers still consider their privacy issues rely on users’ rational and proper use of wearable cameras.
Chapter 6

Covariates Analysis

In this chapter, we report the data analysis of association and correlation between the observers’ perception of wearable cameras in each scenario and covariates including gender, age, technology use history, previous exposure to wearable technology and media effect.

Gender and Age Effect

Privacy Perceptions and Gender

Several previous studies report that females generally perceived the risk of information disclosure higher and concern more about their privacy than males (Friedman, 2006). We want to examine whether this gender effect also exists in their perception of wearable cameras.

General Perception

As shown in Table 6-1, in most scenarios, more females than males choose that they will not accept the use of wearable devices, or can only accept as long as they are not being recorded. From the Chi-square test, this contrast is significant only shown in the travel scenario, with a marginal significance value for fitness, bank, and shopping. We also examined their reaction in each scenario in Table 6-2. Females are more likely to report that they will act differently when wearable cameras exist nearby, while males tend to act as normal. However, the difference is only significant in fitness and dating scenario, which shows females may consider these two scenarios more private than males. Interestingly, we find that their reactions are also marginally
significantly different in the bank scenario, but males tend to act differently under this circumstance, and more males show the idea that they will not accept the use of wearable cameras than females in Table 6-1.

Table 6-1 Distribution of Perception: Males and Females

<table>
<thead>
<tr>
<th></th>
<th>Travelling ($\chi^2(5) = 14.785, p = .011$)</th>
<th>Fitness</th>
<th>Home Party</th>
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</thead>
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<tr>
<td></td>
<td>![bar chart]</td>
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<td>Costume Party</td>
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<td>![bar chart]</td>
</tr>
<tr>
<td>Bank</td>
<td>![bar chart]</td>
<td>![bar chart]</td>
<td>![bar chart]</td>
</tr>
<tr>
<td>Grocery Store</td>
<td>![bar chart]</td>
<td>![bar chart]</td>
<td>![bar chart]</td>
</tr>
</tbody>
</table>

Table 6-2 Distribution of Reaction: Males and Females

<table>
<thead>
<tr>
<th></th>
<th>Travelling</th>
<th>Fitness ($\chi^2(2) = 9.583, p = .008$)</th>
<th>Home Party</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>![bar chart]</td>
<td>![bar chart]</td>
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</tr>
<tr>
<td>Dating</td>
<td>![bar chart]</td>
<td>![bar chart]</td>
<td>![bar chart]</td>
</tr>
<tr>
<td>Costume Party</td>
<td>![bar chart]</td>
<td>![bar chart]</td>
<td>![bar chart]</td>
</tr>
<tr>
<td>Bank</td>
<td>![bar chart]</td>
<td>![bar chart]</td>
<td>![bar chart]</td>
</tr>
<tr>
<td>Grocery Store</td>
<td>![bar chart]</td>
<td>![bar chart]</td>
<td>![bar chart]</td>
</tr>
</tbody>
</table>

Office | Hospital
Additionally, we also examine the level of independence between their agreements on the three statements of how they will react differently and their gender group. There is a statistically significant independence between gender and the agreement on “I would care more about their own activity” with $\chi^2(4) = 22.708, p < .0005$ and “I would leave the place” with $\chi^2(4) = 40.032, p < .0005$. In details, females will more likely change their own behaviors when they find there is a potential risk that their privacy will be invaded, when comparing with males. But there is no significant difference between the agreements on “I will ask the user to stop using it” and their gender.

**Concern about Types of Information**

We examine the association of each type of information with their gender as well. In general, the observers’ privacy concerns about all types of information have a statistically significant association with their gender. Referring to the post hoc test, females have higher privacy concerns in all type of information than males except for financial information. Figure 6-1 and 6-2 shows their concern about personal characteristics and concern about association, where we can see the significant difference of distribution. Results of the Chi-square test are shown in Table 6-3.
Concerns about Personal Characteristics Information: Males and Females

Concerns about Association and Companions: Males and Females

Note that we found no significant post hoc difference regarding concerns for financial information; we think both gender groups have relatively high concerns about this type of information. As well, the results of their general perception and reaction indicate that males show an even higher sensitivity to the bank scenario than females, which may imply a greater concern for information potentially disclosed in this scenario (i.e. financial information). Therefore, no significant difference is shown in this case.

Table 6-3 Association between Gender and Concern about Information Type

|--------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|

Table 6-4 Association between Gender and Concern about Information Control and Practice
Meanwhile, there is also significant association of their concern about information control and practice and their gender group shown in Table 6-4. The detailed post hoc test indicates that females are more concerned about all of the ways in which information will be used and processed than males. In general, our results conform with previous studies that females generally have greater privacy concerns about wearable cameras than males. Nevertheless, males are more concerned about their privacy in some specific scenarios such as bank scenario.

### Privacy Perceptions and Age

Researchers find that older people usually have greater concerns about privacy than younger group (Goldfarb et al., 2012). In our study, we want to investigate whether the observers’ concern about wearable cameras associates with their age group.

### Correlation between Age Group and Concern about Types of Information

Because there is no significance shown in the association between age group and their general perception of as well as reaction to wearable cameras, we look at their concern about each type of information in detail. Both age group and concern about each type of information are

<table>
<thead>
<tr>
<th>Whether information is collected</th>
<th>$\chi^2(4) = 47.494, p &lt; .0005$</th>
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</thead>
<tbody>
<tr>
<td>Who collect the information</td>
<td>$\chi^2(4) = 47.523, p &lt; .0005$</td>
</tr>
<tr>
<td>Don’t know the user</td>
<td>$\chi^2(4) = 45.178, p &lt; .0005$</td>
</tr>
<tr>
<td>Information will be modified by user</td>
<td>$\chi^2(4) = 44.482, p &lt; .0005$</td>
</tr>
<tr>
<td>Information will be modified by others</td>
<td>$\chi^2(4) = 47.610, p &lt; .0005$</td>
</tr>
<tr>
<td>Information will be accessed by third party</td>
<td>$\chi^2(4) = 47.048, p &lt; .0005$</td>
</tr>
<tr>
<td>Information will be wrongly interpreted</td>
<td>$\chi^2(4) = 30.898, p &lt; .0005$</td>
</tr>
<tr>
<td>Information will be used in a database</td>
<td>$\chi^2(4) = 29.208, p &lt; .0005$</td>
</tr>
<tr>
<td>Information will be posted to public network</td>
<td>$\chi^2(4) = 59.301, p &lt; .0005$</td>
</tr>
<tr>
<td>Information recorded will bring real-life risk</td>
<td>$\chi^2(4) = 43.081, p &lt; .0005$</td>
</tr>
</tbody>
</table>
ordinal data, so we use Spearman Correlation test to examine whether their concern is correlated with age group. As shown in Table 6-5, all of the eight types of information are significantly correlated with their concern, and the correlation is weakly positive; that is, older respondents tend to report a greater concern. Among the eight types of private information, the correlation between age group and financial information is the strongest. We used a five-point Likert Scale as the metric for their concern with 5 referring to most concern and 1 referring to least concern. Therefore, we can conclude that older people have greater concerns about each type of information, although the correlation is weak.

Table 6-5 Correlation Table of Age Group and Types of Information

<table>
<thead>
<tr>
<th></th>
<th>personal</th>
<th>Images/videos</th>
<th>Action</th>
<th>Communication</th>
<th>emotion</th>
<th>Association</th>
<th>location</th>
<th>financial information</th>
</tr>
</thead>
<tbody>
<tr>
<td>( r_s )</td>
<td>0.081</td>
<td>0.111</td>
<td>0.114</td>
<td>0.147</td>
<td>0.099</td>
<td>0.108</td>
<td>0.087</td>
<td>0.189</td>
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<tr>
<td>( df )</td>
<td>1136</td>
<td>1145</td>
<td>1175</td>
<td>1178</td>
<td>1173</td>
<td>1177</td>
<td>1182</td>
<td>1119</td>
</tr>
<tr>
<td>( p )</td>
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<td>&lt;.0005</td>
<td>&lt;.0005</td>
<td>&lt;.0005</td>
<td>&lt;.0005</td>
<td>&lt;.0005</td>
<td>0.003</td>
<td>&lt;.0005</td>
</tr>
</tbody>
</table>

In addition, their concerns about information control and practice are also significantly correlated with their age group as shown in Table 6-6. Among these concerns, the correlation is stronger for unfamiliarity with the user and possibility of being posted to public network. Since younger people are more familiar with social media sites and application such as Facebook and Instagram, they may have smaller concern about the post than older group. In summary, older people are concerned more about how their information will be used and processed either by the user or by others. This result also conforms to conclusions drawn by other researchers.
Table 6-6 Correlation Table of Age Group and Concern about Information Control and Practice

<table>
<thead>
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<td>$r_s$</td>
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<td>Who collect the information</td>
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<td>Information will be modified by others</td>
<td>.176</td>
</tr>
<tr>
<td>Information will be accessed by third party</td>
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<tr>
<td>Information will be wrongly interpreted</td>
<td>.180</td>
</tr>
<tr>
<td>Information will be used in a database</td>
<td>.156</td>
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<tr>
<td>Information will be posted to public network</td>
<td>.215</td>
</tr>
<tr>
<td>Information recorded will bring real-life risk</td>
<td>.178</td>
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</table>

**Effect of Technology Use**

**Experience with Computer, Internet and Smartphone**

When an innovative technology is emerging and promoted on the market, it will inevitably evoke some concerns by the users as it is first encountered. We wanted to explore whether their previous experiences with other technologies are associated with their concerns about the new technology. Therefore, we asked participants about how long they have used computer, Internet and smartphones.
Correlation between Experience with Existing Technology and Concern about Types of Information

The self-reported length of technology use and privacy concern are ordinal data, so we used Spearman correlations to assess the relationship between their year of computer using and concern about types of information. Except for their personal characteristics and emotion information, the results indicate there is a weakly positive correlation between their length of computer use and history privacy concerns (Table 6-7). Meanwhile, the positive correlation also exists between their years of Internet use and concerns for information including current action, communication, location and financial information. Among these types of information, the correlation is stronger in current communication and financial information with both computer and Internet use history. When looking back to the difference between each type of information, we find that correlation exists in the information with greater concern and is not significant in information with lower concern.

In general, the participants with longer use history of computer and Internet have greater concerns for several type of information. Nevertheless, although the significant association is shown between years of smartphone use and their privacy concerns, we do not find correlation there.
Table 6-7 Correlation between Computer/Internet Use History and Concern about Types of Information

<table>
<thead>
<tr>
<th></th>
<th>years of computer use</th>
<th></th>
<th></th>
<th>years of Internet use</th>
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<tbody>
<tr>
<td></td>
<td>$r_s$</td>
<td>$df$</td>
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<td>$p$</td>
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<td>.116</td>
<td>1175</td>
<td>&lt;.0005</td>
<td>.076</td>
<td>1175</td>
<td>.009</td>
</tr>
<tr>
<td>communication</td>
<td>.165</td>
<td>1178</td>
<td>&lt;.0005</td>
<td>.106</td>
<td>1178</td>
<td>&lt;.0005</td>
</tr>
<tr>
<td>emotion/facial expression</td>
<td>.045</td>
<td>1173</td>
<td>.122</td>
<td>.026</td>
<td>1173</td>
<td>.378</td>
</tr>
<tr>
<td>association</td>
<td>.085</td>
<td>1177</td>
<td>.003</td>
<td>.043</td>
<td>1177</td>
<td>.138</td>
</tr>
<tr>
<td>location</td>
<td>.128</td>
<td>1182</td>
<td>&lt;.0005</td>
<td>.049</td>
<td>1182</td>
<td>.093</td>
</tr>
<tr>
<td>financial information</td>
<td>.163</td>
<td>1119</td>
<td>&lt;.0005</td>
<td>.101</td>
<td>1119</td>
<td>.001</td>
</tr>
</tbody>
</table>

Experience with Existing Technology and Concern about Information Control and Practice

We also used correlations to identify the correspondence between length of technology use and concerns about information control and practice. There are weakly positive correlations between types of concern and years of computer use as well as years of Internet use. The positive correlations also exist between their years of smartphone use and concerns for “whether information will be recorded” “which information will be recorded” and “don’t know the use”. In details, if the participants have greater concerns about a particular way of how information will be used and processed, the correlation between the concern and technology use history will be stronger than others. In general, we state a similar conclusion here: people who use technology for a longer time have higher privacy concerns than novice technology users.
Experience with Wearable Devices

Some participants in the focus group suggested that people may have concerns about wearable cameras because they are not yet familiar with the novel technology. Therefore, we asked the survey participants about their experience with wearable devices and wearable cameras, and explored whether their experiences will affect the privacy concerns.

Experience with Wearable Device and Concern about Types of Information

From the results shown in Table 6-9, we can see that previous use of wearable devices is significantly associated with concern for current action, communication and financial information and marginally significantly associated with their personal information and characteristics.
In detail, users of wearable devices report lower privacy concerns than non-users. Although their knowledge of wearable cameras does not show a significant association with level of concern, we find that whether they have once heard of “Google Glass” significantly associated with their level of the privacy concern for current action, emotion, location and financial information, and marginally associated with concern for personal characteristics and communication. And, people with knowledge of Google Glass have lower privacy concern than people unfamiliar with this type of product. Therefore, we argue that when people become more familiar with new technologies, their privacy concerns will become lower (as suggested in the focus groups).

Table 6-9 Association between Wearable Device Experience and Concern about Types of Information

<table>
<thead>
<tr>
<th></th>
<th>use of wearable device</th>
<th>know wearable camera</th>
<th>know Google-glass</th>
</tr>
</thead>
<tbody>
<tr>
<td>personal characteristics</td>
<td>$\chi^2(4) = 9.398$, $p = .052$</td>
<td>$\chi^2(4) = 2.555$, $p = .635$</td>
<td>$\chi^2(4) = 9.271$, $p = .055$</td>
</tr>
<tr>
<td>images and videos</td>
<td>$\chi^2(4) = 9.244$, $p = .055$</td>
<td>$\chi^2(4) = 11.614$, $p = .020$</td>
<td>$\chi^2(4) = 4.621$, $p = .320$</td>
</tr>
<tr>
<td>current action</td>
<td>$\chi^2(4) = 9.913$, $p = .042$</td>
<td>$\chi^2(4) = 4.178$, $p = .382$</td>
<td>$\chi^2(4) = 12.370$, $p = .015$</td>
</tr>
<tr>
<td>current communication</td>
<td>$\chi^2(4) = 11.340$, $p = .023$</td>
<td>$\chi^2(4) = 5.476$, $p = .242$</td>
<td>$\chi^2(4) = 9.241$, $p = .055$</td>
</tr>
<tr>
<td>emotion/ facial expression</td>
<td>$\chi^2(4) = 6.060$, $p = .195$</td>
<td>$\chi^2(4) = 1.606$, $p = .808$</td>
<td>$\chi^2(4) = 28.359$, $p &lt; .0005$</td>
</tr>
<tr>
<td>association</td>
<td>$\chi^2(4) = 2.846$, $p = .584$</td>
<td>$\chi^2(4) = 4.730$, $p = .316$</td>
<td>$\chi^2(4) = 15.191$, $p = .004$</td>
</tr>
<tr>
<td>Location</td>
<td>$\chi^2(4) = 6.949$, $p = .139$</td>
<td>$\chi^2(4) = 3.969$, $p = .410$</td>
<td>$\chi^2(4) = 20.863$, $p &lt; .0005$</td>
</tr>
<tr>
<td>financial information</td>
<td>$\chi^2(4) = 15.489$, $p = .004$</td>
<td>$\chi^2(4) = 7.017$, $p = .135$</td>
<td>$\chi^2(4) = 6.952$, $p = .138$</td>
</tr>
</tbody>
</table>

*Experience with Wearable Device and Concern about Information Control and Practice*

We conducted a similar analysis to investigate the effect of previous experience of wearable devices and wearable cameras. As shown in Table 6-10, we found that their previous use of wearable devices was significantly or marginally associated with concerns about how
information will be used and processed; and that users of wearable devices perceived the privacy concerns lower than non-users. Whether they have once heard of “Google Glass” is significantly associated with their concerns, while it is marginally associated with concern for ‘information will be used in a database’. As well, people with knowledge of Google Glass had lower privacy concern with people unfamiliar with this type of product. For these two covariates, we achieve the same conclusion as getting in concerns for different types of information.

Table 6-10 Association between Wearable Device Experience and Concern about Information Control and Practice

<table>
<thead>
<tr>
<th></th>
<th>use of wearable device</th>
<th>know wearable camera</th>
<th>know Google-glass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whether information is collected</td>
<td>$X^2(4) = 8.834, p = .065$</td>
<td>$X^2(4) = 1.467, p = .832$</td>
<td>$X^2(4) = 12.652, p = .013$</td>
</tr>
<tr>
<td>Who collect the information</td>
<td>$X^2(4) = 14.495, p &lt; .006$</td>
<td>$X^2(4) = 5.969, p = .201$</td>
<td>$X^2(4) = 13.298, p = .010$</td>
</tr>
<tr>
<td>Don’t know the user</td>
<td>$X^2(4) = 12.893, p = .012$</td>
<td>$X^2(4) = 3.18, p = .528$</td>
<td>$X^2(4) = 29.752, p &lt; .0005$</td>
</tr>
<tr>
<td>Information will be modified by user</td>
<td>$X^2(4) = 24.306, p &lt; .0005$</td>
<td>$X^2(4) = 5.980, p = .201$</td>
<td>$X^2(4) = 21.073, p &lt; .0005$</td>
</tr>
<tr>
<td>Information will be modified by others</td>
<td>$X^2(4) = 25.644, p &lt; .0005$</td>
<td>$X^2(4) = 1.468, p = .832$</td>
<td>$X^2(4) = 13.064, p = .011$</td>
</tr>
<tr>
<td>Information will be accessed by third party</td>
<td>$X^2(4) = 17.002, p = .002$</td>
<td>$X^2(4) = 2.968, p = .563$</td>
<td>$X^2(4) = 21.362, p &lt; .0001$</td>
</tr>
<tr>
<td>Information will be wrongly interpreted</td>
<td>$X^2(4) = 10.579, p = .032$</td>
<td>$X^2(4) = 3.102, p = .541$</td>
<td>$X^2(4) = 15.584, p = .004$</td>
</tr>
<tr>
<td>Information will be used in a database</td>
<td>$X^2(4) = 8.949, p = .062$</td>
<td>$X^2(4) = 1.059, p = .901$</td>
<td>$X^2(4) = 8.969, p = .062$</td>
</tr>
<tr>
<td>Information will be posted to public network</td>
<td>$X^2(4) = 23.048, p &lt; .0005$</td>
<td>$X^2(4) = 7.723, p = .102$</td>
<td>$X^2(4) = 22.587, p &lt; .0005$</td>
</tr>
<tr>
<td>Information recorded will bring real-life risk</td>
<td>$X^2(4) = 8.359, p = .079$</td>
<td>$X^2(4) = 1.117, p = .087$</td>
<td>$X^2(4) = 26.708, p &lt; .0005$</td>
</tr>
</tbody>
</table>

**Effect of Media Exposure**

Finally, we asked participants whether they have experienced any invasion of their private information, and whether they have heard news about information disclosure. It is
interesting to find that the media exposure to privacy invasion news does impact their privacy perceptions, but their own experiences seems not to have the same effect.

As shown in Table 6-11, their concerns for personal characteristics, current action, communication, location and financial information are significantly associated with whether they have ever heard or seen news about privacy invasion; a marginal association exists between concern about images and emotion with media exposure. Looking back to Chapter 5, concerns about these types of information rank higher. There is no significant association between their companions and media exposure, while concerns about this type of information rank lower than others. Figure 6-3 shows how their concern about financial information differs between participants who have seen news about privacy invasion information and those who have not.

Table 6-11 Association Between Media Exposure and Concern about Types of Information

<table>
<thead>
<tr>
<th>Concern Type</th>
<th>Media Exposure</th>
<th>$\chi^2(4)$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal characteristics</td>
<td></td>
<td>$13.289$</td>
<td>.010</td>
</tr>
<tr>
<td>Images and videos</td>
<td></td>
<td>$9.479$</td>
<td>.050</td>
</tr>
<tr>
<td>Current action</td>
<td></td>
<td>$12.102$</td>
<td>.017</td>
</tr>
<tr>
<td>Current communication</td>
<td></td>
<td>$15.29$</td>
<td>.004</td>
</tr>
<tr>
<td>Emotion and facial expression</td>
<td></td>
<td>$8.675$</td>
<td>.070</td>
</tr>
<tr>
<td>Association and companions</td>
<td></td>
<td>$6.554$</td>
<td>.161</td>
</tr>
<tr>
<td>Location</td>
<td></td>
<td>$16.034$</td>
<td>.003</td>
</tr>
<tr>
<td>Financial information</td>
<td></td>
<td>$30.058$</td>
<td>&lt;.0005</td>
</tr>
</tbody>
</table>
Meanwhile, as shown in Table 6-12, the observers’ concern about information control and practice is significantly associated with media exposure to privacy invasion news as well. Figure 6-4 represents how their concern about whether the information will be collected differs between group of participants who have seen news about privacy invasion information and who have not. Generally, the participants who have more exposure to privacy invasion news express a higher concern about not only several type of information, but also how their information will be used and processes by user of wearable cameras and other third-party people organization.
Table 6-12 Association between Media Exposure and Concern about Information Control and Practice

<table>
<thead>
<tr>
<th></th>
<th>years of computer use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whether information is collected</td>
<td>$\chi^2(4) = 52.682, p &lt; .0005$</td>
</tr>
<tr>
<td>Who collect the information</td>
<td>$\chi^2(4) = 41.599, p &lt; .0005$</td>
</tr>
<tr>
<td>Don’t know the user</td>
<td>$\chi^2(4) = 51.162, p &lt; .0005$</td>
</tr>
<tr>
<td>Information will be modified by user</td>
<td>$\chi^2(4) = 45.529, p &lt; .0005$</td>
</tr>
<tr>
<td>Information will be modified by others</td>
<td>$\chi^2(4) = 38.075, p &lt; .0005$</td>
</tr>
<tr>
<td>Information will be accessed by third party</td>
<td>$\chi^2(4) = 26.343, p &lt; .0005$</td>
</tr>
<tr>
<td>Information will be wrongly interpreted</td>
<td>$\chi^2(4) = 24.264, p &lt; .0005$</td>
</tr>
<tr>
<td>Information will be used in a database</td>
<td>$\chi^2(4) = 17.527, p &lt; .0005$</td>
</tr>
<tr>
<td>Information will be posted to public network</td>
<td>$\chi^2(4) = 50.205, p &lt; .0005$</td>
</tr>
<tr>
<td>Information recorded will bring real-life risk</td>
<td>$\chi^2(4) = 13.997, p = .007$</td>
</tr>
</tbody>
</table>

In summary, the covariates test shows that even if different groups of observers may not show significant difference in their general concerns about wearable cameras, their concern about some specific type of information and ways of using and processing the information will be significantly different. Therefore, it is valuable for use to investigate their perceptions in details regarding types of information as well as information control and practice.
Chapter 7
Discussion, Insights, Limitations and Conclusion

Discussion

Privacy Concerns Are Scenario-Dependent

Most participants hold the opinion that generally they can accept the use of wearable cameras, but nonetheless have some privacy concerns about it as an observer. Their concerns appear to be different when considering their role as an observer in different scenarios. In this study, we designed nine different scenarios that varied according to the location in which the wearable camera appeared and the sensitivity of the observer’s activity at that moment in time. Some scenarios depicted activities happening in daily life without the display of any private information; these included travelling and getting together with friends. We considered these to have a low risk of privacy invasion.

Next, we proposed that activities that are part of one’s private social life (e.g., dating or a party) involve the disclosure of somewhat more private information and thus might raise a moderate privacy concern. Finally, personal activities that depend on very sensitive information (e.g., financial records, health issues, or business-confidential information) were expected to raise the highest level of privacy concern.

With respect to location, we reasoned that activities taking place in public locations have no a priori sense of privacy, because these are places where many people can pass through on any given day. Examples included the outdoors, a city street, and a store. The middle-level group
includes places where people might expect some private information to be disclosed, or that there are boundaries that indicate who is “allowed” in the the place. Examples included a fitness club, a friend’s home, and a workplace. Finally, the high-level group used locations which might evoke information that may be sensitive, for example your own home, a bank, or a hospital. As we expected, our data analysis revealed that hypothetical observers’ reactions varied across these activities and settings. We turn now to a discussion of these findings.

*Perceptions are Affected by Personal Activity and Location*

One major theme in participants’ responses is that they tend not to mind the use of wearable cameras as long as they know they are not being recorded; this was a common response across scenarios. But the distribution of other responses varies considerably. In public spaces in which observers would normally be engaged in ordinary actions or anonymous actions, approximately one-third of participants would not mind another person using such a device as long as they do not notice, or sometimes even when they know the user is recording. People walk by quickly and are almost always regulating their actions in public spaces. Therefore, despite not knowing the user’s intentions, the observers have the expectation of themselves that they will not do anything too weird to be captured.

In contrast, for scenarios that would naturally involve private information such as a bank, hospital or confidential office work, more than half of the participants indicated that they would not find the use of wearable cameras to be acceptable, regardless of whether the user is recording or not. When considering settings that involve an unknown user, the participants have concerns about private information. In this light, it was interesting to learn that the participants do not have such great concerns about their homes, where quite a bit of private activity or related records exist, but where they have the dominant control. We think there are two reasons for this: the ongoing
activity described by the scenario and the related length of stay of the camera wearer. For example, we described a get-together by friends and family member, which is not a particularly intimate piece of one’s private life. The user was a delivery driver, who stays just a few minutes when delivering the food, so there is no possibility for him to make a continuous record over a longer period of time. Without this characteristic of constant recording, the observers’ privacy concerns about wearable cameras decrease.

These general results from the survey are consistent with what we found in our qualitative analysis of the focus group comments. For example, our participant in the focus group expressed the idea that “certain situations in the recording and I’m just walking down the street, going to the store whatever, that’s fine like everyday life”, which shows public spaces will be okay for recording. But in some more private locations, they will feel uncomfortable for that as said by one participant “like if you were coming into my home or something like that with Google glass, on I would probably be a little bit freaked out and not want you wear that”.

When considering these results in comparison to other results reported in the literature, Koelle’s group categorized the the contexts into inappropriate scenario, controversial scenarios and appropriate scenarios (Koelle, 2015). Although they did not discussed the scenarios regarding locations and activities, we can find that some of the inappropriate and controversial scenarios are classified or private locations such as courtrooms and working environments, while others are privacy-sensitive activities such as confidential meeting and relaxing at home. Similarly, they found that both the user and the bystander had different perceptions of privacy in various contexts (Koelle, 2015), as what we find in our study.
People Will Respond According to Beliefs about Control and Recording Purposes

Beyond asking about feelings of privacy invasion, we asked participants to predict how they would react if they noticed someone using a wearable camera. We found that their reactions about whether to leave the place or ask the user to stop recording was related to their perceptions of control and recording purpose in a given scenario. Although they do not show great concerns in the home party scenario, this general lack of concern may be due to feeling that they have significant control over what happens in their home setting. For example, instead of choosing to leave the place (their own home!) or to be careful about what they do in the presence of the camera, they have the power to ask the user to stop recording or otherwise using the device.

High agreement on the more direct reaction (asking the person to stop) also appears in the confidential work scenario, where employees may feel they have the right to stop a visitor’s activities to enforce a non-disclosure policy. In scenarios such as the fitness club and dating, the observers have no particular purpose that is contingent on being in this place at this time. They are more likely to agree more with the option of simply leaving the place so as to avoid any risk they may feel in being recorded. When they have a specific purpose for staying in a scenario, such as tasks at a bank or business-confidential work, they are also likely to become more careful about their own actions instead of leaving the place directly. Finally, if they perceive few privacy concerns in a specific scenario, they prefer to act as usual instead of changing the way they react to the use of wearable camera.

As discussed in previous research, privacy is context-sensitive (Nissenbaum, 2004). In their research, they built a framework by three principles, including protecting privacy against intrusive government agents, restricting access to sensitive information and curtailing intrusions into private spaces (Nissenbaum, 1998). These principles were used to analyze whether public surveillance had invaded personal privacy in terms of appropriateness, distribution and justice.
However, since their research focused more on public surveillance, the privacy-sensitive scenarios will be different and may expand to more situations when using a recording technology as a symbiotic device. Therefore, we study the observers’ perception in several common scenarios in daily life. Among nine scenarios we tested in the survey, we conclude that scenario elements including various locations, activities, control powers and purposes will have impact on their privacy concerns about use of wearable cameras. We need to consider the differences of scenarios when designing and conducting research in this area.

**Information Sensitivity Diffs across Scenarios**

We also used the nine scenarios to examine participants’ concerns about eight different types of information that have been discussed by privacy scholars: personal characteristics, images and videos, actions, communication, emotion and facial expression, association and companion, location and financial information. Because we are interested in the comparison between different conditions instead of the absolute value, we used a measure known as “most concern rate” (MCR) to detect concerns about each type of information (Felt et al., 2012; Lee, 2015).

**General Trends across Scenarios and across Types of Information**

We conducted a general analysis to examine of privacy concern for each type of information, using post hoc comparisons for ordinal scale data. Overall, concern about unwanted sharing of financial information was significantly higher than for other information categories. Concerns about current activities, inter-personal communication and location are less severe than
financial information, but a bit higher than others. Sharing of images, emotion and personal associations evoked the lowest levels of concern across scenarios.

Looking within the different scenarios, the observers expressed the greatest concern about privacy of financial information and location. However, we also found that in addition to these high-risk types of information, concerns related to the sharing of communication behavior was higher for the scenarios involving travelling, dating, costume party, business-confidential work and hospital scenarios. This result reinforces comments made in the focus groups, namely that the students were more concerned about social communication than other personal details, especially in scenarios where the communication content may be sensitive such as confidential discussions at work, romantic interactions or medical issues. Additionally, in the fitness scenario, participants expressed moderate concern about unwanted sharing of their current behaviors (presumably working out in some fashion). It may be that fitness is viewed as a more private activity, even though it is often conducted in a public setting like a fitness club; as such the person may want to complete it alone without being recorded or interrupted by others.

When examining the data to see which information types raises the least concern, we found a result that may be connected to observers’ expectations about private information disclosure during social interaction. For example, they seem to care little about someone taking a photo or video if the place is crowded with strangers (e.g., traveling or in a public venue). In these places, it is common to become part of the “background” someone’s photo. So this expectation reduces their concerns about images and videos relative to other types of information. Moreover, in those scenarios without social communication or where the communication is anonymous, one’s association with particular others becomes of less concern.

With respect to information sharing concerns within the different scenarios, we found that when ignoring the type of information, the MCR is lower for the scenarios that involve travelling and a costume party, and higher in the bank, confidential work and hospital scenarios.
This result is just what one would expect, given related privacy perception and reactions for different scenarios reported earlier, as well as our by-design variations in levels of privacy sensitivity. However we did observe some variations in concern about different types of in different scenarios. For example, the highest MCR for images and videos came in the confidential work scenario, perhaps due to the stated non-disclosure policy that would forbid capture of images or video capture relating to work content. As well, this type of information is considered problematic in the fitness scenario, probably because of exercise clothes (and exercise behaviors) that may be embarrassing. In the shopping scenario, observers have the highest concern for financial information when comparing with other scenarios. The reason might be that others can directly see their financial content such as the credit card number.

**Characteristics of the Information Capture Process and Use**

In addition to general concerns about privacy and about a range of types of information that might be captured by a wearable camera, we probed participants’ reactions to 10 different aspects of situation that have been studied by other privacy researchers. We again use the MCR as a way to highlight sources of primary concern, both across and within scenario contexts. As for the other questions, responses regarding these 10 dimensions varied according to both the dimension in question and the individual scenarios.

Collapsing across scenarios, the concerns of “whether information is collected”, “which information is collected” and “don’t know the user {of the camera}” led to higher MCR values. We suggest that these concerns may be tied to the characteristics of wearable cameras. Because of these devices are relatively unobtrusive (perhaps even invisible at times), people may worry that capture is taking place without their knowledge. We also note that our participants’ relative lack of experience with these novel devices may have made it difficult to provide judgments about
other aspects of the capture process, for example relating to intended use, storage, or general safety.

At the other end of the concern continuum, the MCR values for “integrate information to a whole database” and “information recorded would bring real-life risk” are significantly lower than the other aspects. We suggest that people may feel less concern about privacy when they see themselves as just a small entry in a large-scale database (Gambino et al., 2016). Under this circumstance, it may seem challenging to identify any given individual even if the database is hacked or accessed by unauthorized people or organizations. In the focus group interview, the participants expressed high awareness of real-life risks such as personal safety and misunderstanding by others. Because the scenarios we examined in this survey all presented a low possibility to bring real-life risks to the observers, they did not perceive this dimension as a big concern.

When considering shopping-specific trends, we found that the shopping scenario led to increased concern about personal information that will be reused by others, presumably because misuse of financial information would inject considerable risk and trouble into one’s daily life. For both the costume party and fitness scenarios, a relatively high MCR was expressed regarding “information will be posted to social networks” – these are inherently social events and anything negative or embarrassing that happened could lead to personal distress. In a previous study of social networks (Besmer et al., 2010), the users were unwilling to be tagged on photos and wanted to untag themselves, with the rationale of feeling high concern about “weird” personal activities posted online.

Remembering observers’ high concern about the capture of images and videos in the fitness scenario, we hypothesize that the fitness training scenario may be the most inherently “private” activity among the scenarios, even though it takes place in a public place. Therefore, even when observers do not exhibit general privacy concerns or worries about specific types of
information, they may still perceive higher risks in some scenarios when probed in detail about different aspects of the capture process (e.g., whether the information will be used in specific ways). We conclude that the observers could still experience a strong concern about their personal information in some scenarios even though they might not raise a particular type of information as particularly problematic.

**Observers’ Personal Attributes Influence the Nature of Privacy Concerns**

Previous studies about the privacy of the Internet and social medias have reported that users’ gender, age group and previous exposure to technology have a correlation with their concerns (Garbarino et al., 2004; Goldfarb, 2012; Hoofnagle et al., n.d.). We can add to this body of work, reporting an association and correlation between several covariates and the observers’ privacy concerns about wearable cameras regarding different types of information and different dimensions.

Gender is a critical factor which impacts people’s privacy perceptions. In Garbarino’s research, female users perceive a higher level of risk in online purchasing than male users (where the risk is presumably the loss of personally identifying or financial information). Similarly, we found that females show greater overall privacy concerns about wearable cameras than males. In addition, the male participants in the focus group interview expressed more interest in new technology, while female users show more concerns about it. However the two genders agreed with respect to one type of information – financial information – perhaps because it was seen as the the riskiest information in general to be disclosed in the scenarios we designed.

Meanwhile, we found that older people tended to be more concerned about their information privacy than younger people; this tendency holds for almost every type of information and each dimension of concern. One participant in the focus group mentioned that
her parents’ privacy perceptions are entirely different than hers. Although the result was reflected on their age group, we consider that it may also led by culture evolution. As time passed and technology progress, people tend to have lower awareness of privacy issues than before, and it will make novel technology more acceptable than previous products. Another variable having an impact on their concerns is previous exposure to news stories about privacy invasion. If one person has once seen or heard relevant stories and news, their privacy concern of wearable cameras will increase. Interestingly, although we assumed that personal experience of privacy invasion would also influence concerns, our results showed no such pattern. It may be that media exposure has a stronger impact than personal experience in aggravating these sorts of concerns. (Of course the stories written up in the media are likely to also be much more extreme than any individual experience.)

Previous experiences with computer and the Internet are positive indicators of the observers’ privacy concern. People become more sensitive about and more aware of privacy as time progresses (Goldfarb, 2012). Therefore, those who have a longer computer and Internet usage history tend to have stronger concerns about wearable cameras than novices. However, we saw the opposite pattern for having experience with wearable devices and knowledge of Google Glass; people with such experiences have significantly less concern than non-users. Therefore, although general technology experience seems to increase their privacy concern, exposure to and familiarity with the specific technology in question (a wearable camera) lowers their concerns. One possible interpretation is that people tend to have greater concerns when imagining the use of a novel product in place of referring to firsthand experience. Another possibility is that the individuals who do have wearable camera experience are at the high end of technology sophistication and thus may feel that they can better understand and control situations involving such technologies.
Insights

Using Wearable Cameras in Assistance and Safety as A Starting Point

Although observers can accept the use of the wearable camera in some situations, people show considerable concern about such devices being used as an individual consumer product. But we also found that privacy concerns decrease and acceptance rates rises, when considering it as assistive technology or public safety camera. We suggest that this may be a good starting point to introduce its use into various kinds of scenarios, e.g. as a mechanism for assisting people with impairments.

Video/audio recorder and hearing aids are common devices used in classrooms for students with a range of learning disorders. Although such technologies may hinder others’ learning processes or bring some difficulty to the instructor, people do tend to show sympathy and empathy for this user group. Our participants express their similar opinions in both focus group interview and online survey regarding the use of wearable cameras. Because in these cases the users have a particular purpose to use the device, it is seen as less likely to be used for intentional recording of others. Nevertheless, we should recognize that the observers still have concerns about potential abuse of the device. Perhaps the wearable camera for special user groups such as this can be standardized, helping to make it both noticeable and recognizable for what it is (e.g., a service dog wears certain indicators). Regulations and a simple identity check before purchasing can reduce the possibility of abusing wearable cameras.

We can also consider using a device such as this for the purposes of public safety, although the acceptance rate regarding this situation was less consensual than its use as assistive technology. Public surveillance systems exist in many public spaces, but the fixed cameras are not as flexible and useful as wearable cameras. If police begin to use this type of device during
their active duty, they can capture anything happening urgently and unexpectedly such as an attack or physical crime. Also, this device can help them record the evidence when there is no witness (McGrath, 2004). As a result, the observers will trust the user (police officer) and content even if they assume that the device is recording or processing visual information. Many hold the opinion that public safety weights against personal privacy, and that legitimate organization and authorities are trustworthy. In contrast, others have fear of the “big brother” phenomenon, so the authorities should be careful to avoid abuse of the device and infringe the observers’ privacy, which may on the contrary lead to greater concerns.

By using the wearable camera as personal assistive technology and public safety device, the society and observers will become familiar with this type of device, and their privacy concern about it will lower with time progress. Thus, it can start to produce individual consumer version for daily use.

**Regulation Goes beyond Technology**

Many participants in our studies mentioned that regulations and policies should be made before wearable cameras make large inroads into the consumer market. Researchers studying privacy law have discussed how the emergence of Google Glass has had an impact on regulatory frameworks as well (Meese, 2014). The observers’ current concerns seem tied to the free manner in which wearable cameras are used, leading to extreme portability and invisibility. It is hard to imagine the extremely worst case of abusing the device without any limitations.

We suggest the government and authorities can consider regulations from three perspectives. First, we have to draw a line between camera-free areas and no-camera areas. Currently, digital cameras and smartphones are prohibited in some places such as museums, theatres and confidential workspaces. It is necessary for the policymaker to consider whether we
will simply leverage the regulations for existing devices or tailor it based on the unique characteristics of wearable cameras. Second, regulations should also be created to manage the features of wearable cameras. For example, some countries require smartphone makers to create a sound when the shutter opens or closes, even if a device is in the silent mode, so that observers in the near area have a chance to notice the change in status. An indicator light could be another essential function to alert other people. Under these requirements, observers might feel much comfortable simply by knowing whether a camera is recording or not. Finally, regulators should consider policies about the recorded contents as well. With the development of technology, computers can recognize the identity of people captured in photos and videos. We should think about whether the company should be required to notify people in the photos and give them the right to remove or blur their information.

With regulations and policies, the design of new wearable cameras can be more normative, and people can be familiar with the functions in advance. Therefore, the observers and society can be reassured that use of wearable cameras is still under control so that their privacy will not be easily invaded by this novel device.

Promotion with Baby Steps

Currently wearable cameras and augmented reality technologies are becoming more and more available and viable in the form of personal digital devices, but none have been used by a large group of individual users. As our participants discussed in the focus group, it is difficult for this larger group of people to accept a novel technology immediately. We recommend that the industry should take each small steps during development and marketing of such devices, so that society can accept this device gradually.
Because people who are already using wearable devices like Google Glass show less concern about wearable cameras, they can be the early adopters of this innovative technology. Those people are familiar with the technology and know the functions much better than other. In their everyday activities they might assist with the diffusion of wearable cameras through their casual social communication channels (Rogers, 1995). Meanwhile, the industry should seek opportunities for observers to be exposed to the positive perspectives of wearable cameras (e.g., in support of security or people who are disabled), ensuring that these episodes are covered by the media, because our findings suggest that media exposure will have an impact on privacy concerns. For examples, such activities might show how the advantage of a wearable camera is worth the risk or information disclosure, or how the technology can actively protect private information.

Researchers or companies interested in popularizing these types of technology should also consider the different perceptions of users in various gender and age groupings. The different groups have their particular concerns and expectations of this technology, so the promotion strategy should be tailored to meet these expectations and reduce their concerns. At last, they should consider the observers’ expectation in various scenarios as we discussed above to reduce each particular concern.

In general, we recommend the designers and researchers should not only focus on the technology, but should also consider the scenarios where people will make use of the technology. The novel technology will affect the behaviors and attitude of every individual in the society, while their perception will in turn have impact on how the technology will be used as well. By taking these steps, we hope the whole society can accept the use of wearable cameras as an individual consumer product and dispel their concerns gradually.
Finally, we suggest that the industry should consider developing anti-recording applications together with the development of wearable cameras. In the age of sensing and ubiquitous computing, people face the risk of being recorded and tracked all the time in virtually any place without notification or authorization. Previous studies have explored applications that could notify the users about whether they are being recorded, how their information is stored and used and how to remove their information from the storage (Langheinrich, 2002; Pidcock, 2011). This approach can be applied to wearable camera situations as well.

The application can be either implemented in the smartphones or other existing systems and devices. Here we recommend a few essential features that should be included in such an application. Initially, it should be able to notify the observers whether and how many wearable cameras are nearby and indicate their current operational status. Because of the relative invisibility of wearable cameras, this feature would help to make them “visible” to some extent.

Assuming that a recording is made, observers should be able to review and manage the records that contain their personal information. Due to consideration of others’ privacy, the application should blur other parts of the records and feature only the information related to the particular observer to be reviewed. By this means, the observers begin to have control over their personal information, whether is was recorded intentionally or accidentally by others (similar to the “untag” action in social media). The ideal application will be able to monitor the recorded contents in real time, and actively blur or remove the information that the observers would not like to be tracked. Under this circumstance, people can set up their concerned information in advance, and the requirements will be processed by the application automatically. They will not need to be concerned about information disclosure under the protection.
We should note anti-recording technologies such as we have envisioned may bring their own privacy concerns, as they imply a capability to recognize the personal information automatically. The industry should be careful about downsides of the application during development. Nevertheless, we believe that the application can reduce the observers’ concern effectively and make them less scary of wearable cameras.

Limitations

This study is mainly limited by the participants’ current knowledge of wearable cameras. As a novel technology, most of the participants do not have a clear idea about the functionality and characteristics of the device, and they can only imagine based on their exposure to the introduction and discussion of some leading products in this category such as Google Glass. In research about privacy issues, “privacy paradox” always exists when the participants were asked to report their privacy concern by themselves. How they will react to the technology is generally different from what they express in the study. Therefore, the participants may evaluate their privacy concern about wearable cameras to be greater than they would really experience in daily life. Due to this problem, we did not report the results such as whether they have concern and which level of concern they have. Instead, we analyze and discuss the results by using comparison and relative value.

Meanwhile, we take a scenario-based approach to the online survey that describes each scenario in detail and ask the questions within each scenario. Although we give some detailed information in the scenario description, the participant would still interpret and build the scenario in their mind based on personal experience and expectation. Thus, it affects the consistency of conditions for each participant. For instance, in the office scenario, some participants may consider the user as a general visitor to the company, but others may think the user would intend
to record confidential data of the company. In this case, their reference for measuring general perception and perceived concern about each type of information may severely differ with each other. Also, the observers tend to be more suspicious when they are in virtually designed scenarios than in real world settings.

For the focus group, we recruited undergraduate students as participants, and most of them are majoring in Information Science and Security and Risk Analysis. Because of their schooling, they are likely to be more sensitive to the privacy issues than the general population. Also, since different age group show various perceptions of wearable cameras, the ideas about wearable cameras of the sample we used in focus group interview and the sample for the online survey are different. This problem partially explains why we did not get significant results in some questions in the survey, even though issues had been mentioned a lot in the focus group interview. Additionally, since I was the only researcher working on coding and analysis the qualitative data, there exists the possibility that some themes were missed in the analysis.

Finally, because of the participants’ unfamiliarity with wearable cameras and the complexity of designing the survey questions, we find that the participants could not distinguish the difference between some options and evaluate them by the Likert scale properly. For example, in the evaluation of various dimensions of privacy concerns, they show similar attitudes to several dimensions, and we are unable to find any statistically significant difference there. Since we could not ask follow-up questions freely in the online survey, we think it will be better to conduct further interviews or users studies to figure out detailed reasons for these specific questions.

Conclusion

In this study, we used a mix of quantitative and qualitative methods and used a scenario-based approach to explore the observers’ perceived privacy concern in various situations, probing
a number of different types of information and dimensions of privacy concern. As well, we asked for comparison results between wearable cameras with existing technology, and the observers’ attitude towards using this type of device for personal and public good. While previous studies have indicated that privacy concerns are context-sensitive, ours study is the first to provide an in-depth investigation into the different concerns in different scenarios, and how concerns and reaction are related to the observer’s current location, activity, purpose, and feeling of control. Future studies can make use of this method to further explore how wearable cameras will be utilized and will affect people’s perceptions in every aspect of their daily lives in private spaces and public spaces.

We have drawn insights about how to promote and use wearable cameras in future such as to use it as assistive technology and to develop anti-recording application for observers. The industry product team can learn the observers’ ideas as an important stakeholder for the novel type device. Also, the results can help the industry to know how to customize the design and functions of wearable cameras to fulfill the requirements of different groups of observers.
Reference


Hoofnagle, C., King, J., Li, S., & Turow, J. (n.d.). How Different are Young Adults from Older Adults When it Comes to Information Privacy Attitudes and Policies? Available at SSRN 1589864.


Appendix A

Table of Survey Analysis

Table Appendix A-1 Distribution of Participants' Perception in Each Scenario

<table>
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<th></th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
<th>S5</th>
<th>S6</th>
<th>S7</th>
<th>S8</th>
<th>S9</th>
</tr>
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<tr>
<td>I can’t accept someone using</td>
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<td>32</td>
<td>26</td>
<td>14</td>
<td>15</td>
<td>51</td>
<td>31</td>
<td>53</td>
<td>39</td>
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<tr>
<td>this device whether I’m being</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>recorded or not.</td>
<td>6.6%</td>
<td>24.1%</td>
<td>19.7%</td>
<td>10.2%</td>
<td>11.5%</td>
<td>38.1%</td>
<td>23.7%</td>
<td>39.6%</td>
<td>29.5%</td>
</tr>
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<td>13</td>
<td>26</td>
<td>23</td>
<td>16</td>
<td>18</td>
<td>20</td>
<td>37</td>
<td>27</td>
<td>32</td>
</tr>
<tr>
<td>this device, if I know I’m being</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>recorded.</td>
<td>9.6%</td>
<td>19.5%</td>
<td>17.4%</td>
<td>11.7%</td>
<td>13.7%</td>
<td>14.9%</td>
<td>28.2%</td>
<td>20.1%</td>
<td>24.2%</td>
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<td>I don’t mind someone using</td>
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<td>51</td>
<td>53</td>
<td>64</td>
<td>49</td>
<td>47</td>
<td>50</td>
<td>41</td>
<td>44</td>
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<tr>
<td>this device, if I know I’m not</td>
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<tr>
<td>being recorded.</td>
<td>46.3%</td>
<td>38.3%</td>
<td>40.2%</td>
<td>47.4%</td>
<td>37.4%</td>
<td>35.1%</td>
<td>38.2%</td>
<td>30.6%</td>
<td>33.3%</td>
</tr>
<tr>
<td>I don’t mind someone using</td>
<td>22</td>
<td>8</td>
<td>10</td>
<td>15</td>
<td>18</td>
<td>10</td>
<td>2</td>
<td>7</td>
<td>9</td>
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<tr>
<td>this device, if I don’t know</td>
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<td>whether I’m being recorded.</td>
<td>16.2%</td>
<td>6.0%</td>
<td>7.6%</td>
<td>1.9%</td>
<td>13.7%</td>
<td>7.5%</td>
<td>1.5%</td>
<td>5.2%</td>
<td>6.8%</td>
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<tr>
<td>I don’t mind someone using</td>
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<td>15</td>
<td>20</td>
<td>25</td>
<td>30</td>
<td>3</td>
<td>10</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>this device, even I’m being</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>recorded.</td>
<td>19.1%</td>
<td>11.3%</td>
<td>15.2%</td>
<td>18.2%</td>
<td>22.9%</td>
<td>2.2%</td>
<td>7.6%</td>
<td>3.0%</td>
<td>6.1%</td>
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<td>I have no idea about that.</td>
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<td>1</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>0</td>
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<tr>
<td></td>
<td>2.2%</td>
<td>.8%</td>
<td>.0%</td>
<td>1.5%</td>
<td>.8%</td>
<td>2.2%</td>
<td>.8%</td>
<td>1.5%</td>
<td>.0%</td>
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Table Appendix A-2 Distribution of Participants' Potential Reaction in Each Scenario

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<th>S6</th>
<th>S7</th>
<th>S8</th>
<th>S9</th>
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<tr>
<td>I will act differently no</td>
<td>14</td>
<td>33</td>
<td>37</td>
<td>18</td>
<td>28</td>
<td>54</td>
<td>48</td>
<td>60</td>
<td>32</td>
</tr>
<tr>
<td>matter the person is</td>
<td>10.3%</td>
<td>24.8%</td>
<td>28.0%</td>
<td>13.1%</td>
<td>21.4%</td>
<td>40.3%</td>
<td>36.6%</td>
<td>44.8%</td>
<td>32.6%</td>
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<tr>
<td>recording or not.</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I will act as normal if</td>
<td>46</td>
<td>63</td>
<td>42</td>
<td>64</td>
<td>54</td>
<td>51</td>
<td>56</td>
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<td>58</td>
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<tr>
<td>the person is not</td>
<td>33.8%</td>
<td>47.4%</td>
<td>31.8%</td>
<td>46.7%</td>
<td>41.2%</td>
<td>38.1%</td>
<td>43.7%</td>
<td>29.9%</td>
<td>43.9%</td>
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<td>recording anything, but I</td>
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<td>will act differently if I</td>
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<td>know the user is</td>
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<td>recording.</td>
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<td></td>
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<td>I will act as normal no</td>
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<td>37</td>
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<td>31</td>
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<tr>
<td>matter the person is</td>
<td>55.9%</td>
<td>27.8%</td>
<td>40.2%</td>
<td>40.1%</td>
<td>37.4%</td>
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<td>20.6%</td>
<td>25.4%</td>
<td>23.5%</td>
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<td>recording in this</td>
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<td></td>
</tr>
<tr>
<td>scenario or not.</td>
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Table Appendix A-3 Difference of Agreements on Each Statement (AoS) for General Attitude

<table>
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<tr>
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<tbody>
<tr>
<td></td>
<td>1</td>
<td>&lt;.0005</td>
<td>1</td>
<td>1</td>
<td>.009</td>
<td>&lt;.0005</td>
<td>.184</td>
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<td>1</td>
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<tr>
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<tr>
<td>AoS3</td>
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<td>1</td>
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<td>&lt;.0005</td>
<td>&lt;.0005</td>
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<td>&lt;.0005</td>
<td></td>
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<tr>
<td>AoS4</td>
<td>1</td>
<td>1</td>
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<td>&lt;.0005</td>
<td>.518</td>
<td>.016</td>
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<td>&lt;.0005</td>
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<tr>
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<td>.053</td>
<td>1</td>
<td>1</td>
<td>&lt;.0005</td>
<td>.002</td>
<td>.001</td>
<td></td>
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<td>&lt;.0005</td>
<td>.002</td>
<td>&lt;.0005</td>
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<td></td>
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<td>&lt;.0005</td>
<td>&lt;.0005</td>
<td>&lt;.0005</td>
<td>&lt;.0005</td>
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Appendix B

Consent Form of Focus Group Interview

Title of Project: Privacy Concern and User Experience for Wearable Cameras

Principal Investigator: Jun Ge
316C IST Building, University Park, PA 16802
jug264@psu.edu
208-867-6681

Advisor: Dr. Mary Beth Rosson
(814)863-3450

You are being invited to volunteer to participate in a research study. This summary explains information about this research.

1. **Purpose of the Study:** You are invited to participate in a research study that seeks to understand people’s experience and privacy concern about use of wearable cameras and augmented reality technologies. Knowledge gained from this particular study will enable the research team to understand how to design and develop next-generation wearable technology products with considerations for both users and bystanders who are primary and secondary stakeholders of these products.

2. **Procedures to be followed:** If you agree to be in this study, we will ask you to do the following:
   - Watch an introduction video about wearable cameras
   - Answer questions in the survey about your perception and attitude of these devices

3. **Duration/Time:** The study will last about 1 hour. Note that your answers to the interview questions will be recorded but any identifiable information will not be used in the dissemination of the results from this focus group interview.

4. **Discomfort and Risks:** You will not experience risk beyond that of everyday life.

5. **Benefits:** The benefit of this study is to acquire further understanding what privacy concerns of current wearable devices people have. The participant may not benefit personally at this point in the research, but the knowledge acquired through the interviews will enable the research team and other design team to better understand people’s perception, belief and value of these products and develop more acceptable products with better experiences.

6. **Statement of Confidentiality:** Your participation in this research is confidential. The data will be stored and secured at 315 IST in a password-secured computer. In the event
of a publication or presentation resulting from the research, no personally identifiable information will be shared.

7. **Payment for participation:** You will receive 1 extra credit for class IST413.

8. **Voluntary Participation:** Your decision to be in this research is voluntary. You can stop at any time. You do not have to answer any questions that you do not want to answer. Refusal to take part in or withdrawing from the study will involve no penalty or loss of benefits you would receive otherwise.

You must be 18 years of age or older to consent to take part in this research study. If you agree to take part in this research study and the information outlined above, please sign your name and indicate the date below.

If you have questions or concerns, you should contact Jun Ge at (208)867-6681. If you have questions regarding your rights as a research subject or concerns regarding your privacy, you may contact the Office for Research Protections at 814-865-1775.

___Yes, my session may be audio recorded.
___ No, my session may not be audio recorded.

You will be given a copy of this form for your records.

____________________________________   ______________________
Participant Signature                     Date

____________________________________   __12/04/2015__
Person Obtaining Consent                 Date
Appendix C

Focus Group Protocol

Hello everyone, thank you for coming today to participate our focus group interview about wearable cameras. Let’s introduce ourselves.

At first, I will show you an introduction video about what wearable technology is and the current use of wearable cameras.

General Opinions
1. Have you ever heard or seen any kind of “wearable cameras” as shown in the video?
   a. Please describe what the device is?
   b. Please explain the functionality of the device based on your best knowledge?

2. Have you ever heard the term: “Augmented Reality Technology”? Augmented reality (AR) is a live direct or indirect view of a physical, real-world environment whose elements are augmented (or supplemented) by computer-generated sensory input such as sound, video, graphics or GPS data. For instance, when using Microsoft Hololens, the device can recognize items, people’s faces, and details and then show these information on the virtual display.
   a. Please imagine and describe what the main functionality of augmented reality technology is from your own point of view.

3. Have you ever used a wearable device (not only the wearable cameras but also other wearable technology such as smart watch or wrist band)?
   a. Please describe your experiences.
   b. Please think about and discuss some advantages and disadvantages of these devices from your experience.

4. What’s your opinion about the technology introduced in the video? Such as the small wearable camera, the drone or Google Glass
   a. As a user, would you like to use it in your daily life?
      i. Please give reason for why or why not. (good or bad for situation)
   b. Do you have some concerns for using these devices?

Privacy Concerns:
5. Have you once seen someone else use such kind of product (e.g. Google Glass)?
   a. Please describe the situation. E.g., where, when, who, how to use it.
   b. What’s your idea when you see someone is using such a device?

6. Do you have any concerns about someone else using a wearable product?
   a. Please elaborate what your concerns are and explain why you have these concerns.

7. (Some of you described your privacy concerns), In which locations and scenarios you have privacy concerns?
   a. Please describe the scenario and your concerns in details.
   b. Please give the reason for why do you have concerns

8. If you know someone is recording you with this kind of product, which type of private information do you think you have the most privacy concerns in different scenarios in your opinions?
9. (I would like you to think more about you concerns. Can you describe which kind of concern it is such as whether you feel out of control for your personal information or you are afraid of unauthorized access of your personal information form other people’s device?)

10. Is there any exception that you don’t mind people use these products even you are not comfortable with the situation?
   a. Please describe the scenarios.
   b. If the product is an assistive technology such as for visually impaired or deaf people, will it change your attitude? Why?
   c. As needed, please imagine and describe how this technology can be used and will change the interaction between you and these people?

11. Nowadays, we have already been recorded by all kinds of devices such as public close-circuit television and smart phones.
   a. Do you think there are any differences between wearable cameras and public CCTVs and smart phones?
      i. Which device do you think will raise more privacy concerns and why?

12. If this technology becomes popular, how do you think these devices should be used in terms of policy, ethics, device functionality and other issues? And why?

13. Can you brainstorm and describe some solution for design of these products that will make you feel them more acceptable?
Appendix D

Consent Form for Online Survey

Title of Project: Privacy Concern and User Experience for Wearable Cameras

Principal Investigator: Jun Ge
316C IST Building, University Park, PA 16802
jug264@psu.edu; 208-867-6681

1. Purpose of the Study: You are invited to participate in a research study that seeks to understand people’s experience and privacy concern about use of wearable cameras and augmented reality technologies. Knowledge gained from this particular study will enable the research team to understand how to design and develop next-generation wearable technology products with considerations for both users and bystanders who are primary and secondary stakeholders of these products.

2. Procedures to be followed: If you agree to be in this study, we will ask you to do the following:
   • Read the instructions
   • Answer the survey questions

3. Duration/Time: The study will last about 20 minutes. Note that your answer will be recorded but any identifiable information will not be used in the dissemination of the results from this survey. The answer data will be used to understand your ideas about privacy concern and general experiences of wearable cameras.

4. Discomfort and Risks: You will not experience risk beyond that of everyday life.

5. Benefits: The benefit of this study is to acquire further understanding what privacy concerns of current wearable devices people have. The participant may not benefit personally at this point in the research, but the knowledge acquired through the survey will enable the research team and other design team to better understand people’s perception, belief and value of these products and develop more acceptable products with better experiences.

6. Statement of Confidentiality: Your participation in this research is confidential. The data will be stored and secured at 315 IST in a locked file. In the event of a publication or presentation resulting from the research, no personally identifiable information will be shared.

The physical and electronic records of this study will be kept private. In any report that we might publish, we will not include any information that will make it possible to identify a subject. Records will be kept in a locked file in a locked office or on a secure computer system. The audio information will be kept in a separate secure file to insure confidentiality of subjects. Under no circumstances will records be viewed or loaned to
others without your written consent. To comply with federal regulations, all records will be retained for at least three years after the close of this study. After this period, we will destroy the records. In addition, The Pennsylvania State University’s Office of Research Protections, the Institutional Review Board and the Office for Human Research Protections in the Department of Health and Human Services may review records related to this research study.

7. **Right to Ask Questions:** Please contact Jun Ge at 208-867-6681 with questions, complaints or concerns about the research. You can also call this number if you feel this study has harmed you. If you have any questions, concerns, problems about your rights as a research participant or would like to offer input, please contact The Pennsylvania State University’s Office for Research Protections (ORP) at (814) 865-1775. The ORP cannot answer questions about research procedures. Questions about research procedures can be answered by the research team.

8. **Payment for participation:** You will receive 80 cents after successfully and carefully finish the survey and enter the validation code to mTurk.

9. **Voluntary Participation:** Your decision to be in this research is voluntary. You can stop at any time. You do not have to answer any questions that you do not want to answer. Refusal to take part in or withdrawing from the study will involve no penalty or loss of benefits you would receive otherwise.

You must be 18 years of age or older to consent to take part in this research study. If you agree to take part in this research study and the information outlined above, please sign your name and indicate the date below.

Statement of Consent:
I have read the above information, and I consent to take part in the study.

____________________________________  ___________ ____________________
Participant Signature                     Date

____________________________________  ___________ ____________________
Person Obtaining Consent                  Date
Appendix E

Survey Questions

Survey Question – Observers’ Perception of Wearable Cameras

Section 0. Introduction

Hello, thank you for participating this survey.

We are now conducting research on your perception on glass-mounted wearable cameras (e.g., Google Glass).
We are glad to invite you to think about the situation that you are an observer, who finds there’s other person using such a device around you. We would like to know about how you think about the device, your concerns about privacy issues, and the reason for your concerns.
Your answers will help us to study stakeholder’s attitude, belief, values and benefits as an observer of these devices. The results will help the design of these devices, and the development of this research topic related to emerging wearable devices.

The survey will take you about 20 minutes, and will be completely anonymous. Our research team will not share your answers and information to any person or any organization.

If you have any questions about the survey, please email us: junge@psu.edu

Brief Introduction of the Device

Glass-style wearable camera is a wearable computer that adds information to what the wearer sees. As with other life logging and activity tracking devices, the GPS tracking unit and digital camera of some smart-glasses can be used to record historical data. Google Glass is one of the famous products in this category.
Section 1. Technology Usage
In this section, we will ask several questions regarding your technology use history and habits.

1) How many years have you used computer?
   • Less than 1 year
   • 1–3 years
   • 3–5 years
   • 5–10 years
   • more than 10 years

2) How many years have you used Internet?
   • Less than 1 year
   • 1–3 years
   • 3–5 years
   • 5–10 years
   • more than 10 years

3) How many years have you used smart phones?
   • Less than 1 year
   • 1–3 years
   • 3–5 years
   • 5–10 years
   • more than 10 years

4) Have you once used a wearable device including but not limited to wrist bands, smart watch, wearable camera and so on?
   • Yes
     [1] What is the wearable device?
        o Wrist band
        o Smart watch
        o Wearable camera
        o Others ____________________ (please specify)
   • No

5) Have you ever heard of the glass-style wearable cameras?
   • Yes
     [1] Have you ever tried on any glass-style wearable camera?
        o Yes
        o No
   • No

6) Have you ever heard of “Google Glass”?
   • Yes
     [1] Have you ever tried on Google Glass?
        o Yes
7) If there’s a new technology coming out, what’s your general attitude about it?
   - I will buy and try it without consideration of the price.
   - I will buy it if the price is affordable.
   - I will probably not buy it, but follow up with the features and news.
   - I will not buy it, and don’t have interest in new technology products.
   - Other attitude. Please clarify here_____________________

Section 2. Attitude toward privacy issues of wearable cameras
In this section, you will be required to answer the question based on each SPECIFIC SCENARIO.

- Scenario
  Description of the scenario. (completing scenario list in Appendix F)

You are travelling to other cities.
In a scenic attraction, you park the car, enjoy the scene and plan to take some photos.
At this moment, you notice another tourist is wearing a glass-style wearable camera.

1) What’s your idea about other people using this device when you are in this scenario? Please select from the following statements, which best describe your idea.
   - I can’t accept someone using this device whether I’m being recorded or not.
   - I can’t accept someone using this device, if I know I’m being recorded.
   - I don’t mind someone using this device, if I know I’m not being recorded.
   - I don’t mind someone using this device, if I don’t know whether I’m being recorded or not.
   - I don’t mind someone using this device, even I’m being recorded.
   - I have no idea about that

2) What will be your reaction when you find others using this device in this scenario? Please select from the following statements which best describe your idea.
   - I will act as normal no matter the person is recording in this scenario or not.
   - I will act as normal if I know the person is not recording anything, but I will act differently if I know the person is recording.
• I will act differently no matter the person is recording or not.

3) How will you act differently in this scenario? Please evaluate the following statements by using the 5-point scale.
   • I will be more careful about what I say, how I act and so on.
   • I will leave the place where it is possible to be recorded by the user either intentionally or by accident.
   • I will ask the user to remove the camera and not to record me by using it.

4) How much privacy concern do you have for each type of the information listed below in this specific scenario? Please evaluate each type of information by using the 5-point scale. (5 for most concern and 1 for least concern; NA for not applicable in this scenario)
   • Personal characteristics (such as racial, gender, appearance and so on).
   • Images and.
   • Current action.
   • Current communication.
   • Current emotion and facial expression.
   • Association and companions.
   • Current location.
   • Financial information.
   • Other type of information not listed above ________________

5) To what extent do you have privacy concern for each of the following statement in this specific scenario? Please evaluate by using the 5-point scale. (5 for most concern and 1 for least concern ; NA for not application in this scenario)
   • Without control for whether information is collected.
   • Without control for which information is collected.
   • Don’t know the person who’s recording me.
   • Information might be reused and modified by the user.
   • Information might be reused and modified by the others.
   • Information might be accessed by a third-party person or organization.
   • Information would be wrongly interpreted after recording.
   • Information would be used as an element of a whole database.
   • Information would be posted to public network such as social medias.
   • Information would bring real-life risk to my daily life.
   • Other use not listed above___________________
Section 3.

In the following section, we will ask you some questions about your general attitude to glass-style wearable cameras without consideration of the scenarios.

1) What’s your general attitude to the use of glass-style wearable cameras as an observer? Please select from the following statements, which best describe your idea.
   • As an observer, I can accept use of the device and don’t have any concerns.
   • As an observer, I can accept use of the device but I have some concerns.
   • As an observer, I don’t have any concerns but I can’t accept use of the device.
   • As an observer, I cannot accept use of the device and I have some concerns.

2) Please evaluate the following statements based on your attitude to use of glass-style wearable cameras by using the 5-point scale. (5 for strongly agree and 1 for strongly disagree)
   • People are legal to record in public spaces.
   • People are already legal to record by other devices.
   • I'm not important enough to be recorded as a normal person.
   • Use of the device is a trend in future and observers attitude will progress with time.
   • Personally, I'm very tech savvy and interested in new products.
   • If there's only one person using it around me, it will be weird.
   • If there are many people using it around me, it will be okay.
   • Recording in public spaces may invade others privacy.
   • Recording by glass-style wearable camera is threatening because it's hidden.
   • It's risky to be probably recorded anywhere and any time.
   • It's risky to be recorded by someone unknown.
   • There's no necessity to use this device.
   • Personally, I would not like anyone to record me.

3) Please list here if there are other reasons for you to have this idea.

4) If this glass-style wearable camera is being used for personal good, such as for people with visual impairment, hearing impairment or cognitive disability, what’s your general attitude to seeing other people using it? Please select from the following options which best describe your idea.
   • As an observer, I can accept use of the device and don’t have any
concerns.
• As an observer, I can accept use of the device but I have some concerns.
• As an observer, I don’t have any concerns but I can’t accept use of the device.
• As an observer, I cannot accept use of the device and I have some concerns.

5) What’s the reason for you to have this attitude? Please evaluate the following statements based on your idea by the 5-point scale.

• It's always good to assist people by technology anyhow.
• It's good to assist people by technology as long as it doesn't affect invade other's privacy in public.
• It can be used as long as being standardized.
• It may be abused if there's no limitation.
• There's no necessity to use camera function for assisting people.
• There's no necessity to use this new device for assisting people.

6) If you have other reasons, please list here.

7) If this glass-style wearable camera is being used for public good, such as for monitoring crime, terrorist attack or public safety, what’s your general attitude to seeing other people using it?
Please select from the following options which best describe your idea.
• As an observer, I can accept use of the device and don’t have any concerns.
• As an observer, I can accept use of the device but I have some concerns.
• As an observer, I don’t have any concerns but I can’t accept use of the device.
• As an observer, I cannot accept use of the device and I have some concerns.

8) What’s the reason for you to have this attitude? Please evaluate the following statements based on your idea by the 5-point scale.
• It's important and necessary to monitor for public good.
• Public safety weighs against risk of privacy being invaded.
• There's no necessity to use this device even if for public good.
• There's no necessity to use this device because public cameras such as CCTVs have already worked for this purpose.

9) If you have other reasons, please list here.
10) What's your idea as an observer when comparing glass-style wearable cameras with smart phones?
Please select from the following options which best describe your idea.
• They are the same.
• Glass-style wearable cameras bring more privacy concerns.
• Smart phones bring more privacy concerns.

11) What’s the reason for you to have this attitude? Please evaluate the following statements based on your idea by the 5-point scale.
• People are legal to record by wearable camera where they are legal to record by smart phone.
• If a person would like to record you, they are easy to record by either smart phone or wearable camera.
• Wearable cameras are hidden better, while smart phones are more visible.
• You cannot tell whether a wearable camera is being operated, but it's easy to tell whether a smart phone is recording.
• Wearable cameras can keep recording, while smart phones can only record intentionally to specific area and point.
• Almost everyone has smart phone, but only few people own wearable cameras.

12) If you have other reasons, please list here.

13) What's your idea as an observer when comparing glass-style wearable cameras with public cameras such as close-circuit televisions (CCTVs)?
Please select from the following options which best describe your idea.
• They are the same.
• Glass-style wearable cameras bring more privacy concerns.
• Public cameras bring more privacy concerns.

14) What’s the reason for you to have this attitude? Please evaluate the following statements based on your idea by the 5-point scale.
• People are legal to record by wearable camera where they are legal to record by public cameras.
• Wearable cameras are controlled by individual user, while public cameras are only controlled by trustworthy authorities.
• Wearable cameras are hidden better, while public cameras are more visible.
• You cannot tell whether a wearable camera is being operated, but it's easy to tell that the public cameras are recording.
• Wearable cameras can record anywhere, while public cameras are pointing to specific areas.
• I know the purpose of public cameras, but I don't know the purpose of being recorded by wearable cameras.

15) If you have other reasons, please list here.

16) As an observer, how do you think people WILL use these glass-style wearable cameras? Please use the 5-point scale to evaluate the following statements which best describe your ideas.
• The user will not record me intentionally.
• The user will not record me by accident.
• The user will not misuse my information if they accidentally record me.
• The user will not distribute or post my information if they accidentally record me.
• The user will know the boundary between public and private when recording.
• The user will record me intentionally.
• The user will record me anywhere and any time.
• The user will misuse my information.
• The user will distribute my information.

17) As an observer, how do you think people SHOULD use these glass-style wearable cameras? Please use the 5-point scale to evaluate the following statements which best describe your ideas.
• The user should never record any strangers either intentionally or by accident.
• The user should ask for consent before recording.
• The user should not store or use my information if recorded accidentally.
• The user should know the boundary between public and private when recording.
• The user should comply with the policy of recording.
• The user should not use a wearable camera.

18) What's your perceived level of privacy in the following scenarios? Please select the level of privacy concern by using the 7-point scale. (7 for highest level of concern and 1 for lowest level of concern)
• Traveling to some scenic attractions
• Doing fitness in the gym
• Being with friends in your house
• Dating on the street
• Dancing in a costume party
• Talking to friends in the bank
• Paying in the grocery store
• Working on confidential data in company
• Visiting doctor in the hospital

Section 4. Demographic Questions

1) Have you ever experience invasion of private information?
   • Yes
   • No

2) Please describe your experience for it.

3) Have you ever seen or heard of any news or stories about invasion of private information?
   • Yes
   • No

4) Please describe your experience for it.

5) Gender

6) Age group

7) Income

8) Level of education
Appendix F

Scenario List

1. You are now traveling to other cities. At a scenic attraction, you park the car, enjoy the scene, and plan to take some photos. At this moment, you notice another tourist is wearing a glass-mounted camera.

2. You have a habit of doing some fitness training every day at the gym. This day, you are working out both for strength and aerobics as usual. You find there’s another guy wearing a glass-mounted camera today when you visit the gym.

3. You invite a group of friends to have dinner at your house with your family. You are cooking dinner and your kids are playing in the living room with your friends. When the pizza you ordered is delivered, you find that the driver is wearing a glass-mounted camera when delivering your food.

4. These days, you are dating a new man/woman. During the weekend, you two are taking a walk together down a busy street in your city and making plans. You find there’s another guy wearing a glass-mounted camera. The guy stands in the street corner and seemingly waits for someone else.

5. You are invited by a friend to attend a costume party. Therefore, you do your make-up and dress differently than in your daily life. Since there are only a few people who you know at the party, you have to dance and talk with strangers. In the crowd, you see another guest wearing a glass-mounted camera and moving around the party hall.

6. You go to the bank today. A friend goes to the bank with you. You two are discussing some plans about how to increase your families’ finances. You notice that there’s another customer sitting behind you is playing with a new glass-mounted camera while waiting in the line.

7. Today is your birthday. You decide to buy two bottles of wine to celebrate with your family. When paying at the checkout, you are required to show your ID card and pay by credit card. As you bring your cards out of your pocket, you see another customer in line behind you with a glass-mounted camera.

8. You work as an engineer at a giant IT company. Most of your work is confidential due to company policy.
Today, you are working at your desk as usual. You just noticed that a visitor to your office is wearing a glass-mounted camera when walking around the office and talking with others.

9. This morning, you went by yourself to the hospital. Your main goal is to take an annual health exam. After finishing all of the tests, you are sitting in line and discussing some of your health issues with a nurse in the lobby area. You see another patient in line wearing a glass-mounted camera that you have only seen in videos.