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Video Cameras for Lifelogging at Home: Preferred Visualization Modes, Acceptance, and Privacy Perceptions Among German and Turkish Participants

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Increasing numbers of older individuals in the societies pose great challenges for countries affected by the demographic change. The rapid development in the technological sector, on the other hand, enables various applications to make everyday life easier for older and disabled people and to maintain their autonomy for longer. This study examines the acceptance and privacy perceptions of a video-based technology for lifelogging in home environments among German and Turkish users, using a multi-method empirical research approach. Results expose an overall differing acceptance of using lifelogging cameras between German and Turkish participants and suggest that the consideration of the varying culture-bound demands is necessary. Findings of this study support the understanding of requirements for a successful implementation of a video-based assistive technology in private environments to optimally address the needs of the future users, drawing attention to the important cultural influences that affect its acceptance.

Keywords: Lifelogging Technology, Video-based Technology, Technology Acceptance, Privacy, Culture

Introduction

Addressing societal challenges of an aging population, ambient assisted living (AAL) technologies have emerged within recent decades as providing innovative approaches, which aim at supporting and assistance of older and disabled individuals to live longer autonomously at home (Blackman et al., 2016; Calvaresi et al., 2017). In private spaces in the context of AAL, video-based devices like RGB cameras, RGB-D devices, or thermal cameras are being more frequently used, as computer vision gives the possibility to monitor an environment 24/7 and

report on visual information, which is commonly the most straightforward and natural way of describing an event, a person, an object, actions and interactions.

In the last decade, advances in computational power and computer vision have given video cameras the ability of 'seeing', evolving their functionality to become 'smart cameras'. This has enabled the development of vision-based intelligent systems (e.g., Sefat et al., 2014; Ćirić et al., 2016; Chen et al., 2019) which are not only able to stream video in real time, but also to extract useful information from visual data. Cameras are being used for different AAL applications, e.g., recognition of activities of daily living, human behavior analysis, fall detection and prevention, rehabilitation, gait analysis, promotion of healthy lifestyles, and physiological monitoring; Climent-Pérez et al. (2019) provide a review of technologies, algorithms, and applications of lifelogging cameras for AAL. Such vision-based technology enables not only to support people in their active and healthy aging, but also to retain or even increase their autonomy and mobility in everyday life. Thus, for aging societies, resulting from demographic shifts which currently occur in most Western countries of the world, this technology has a big potential.

However, this type of monitoring using cameras for lifelogging can be seen as intrusive and violating rights to the users' privacy, because of the concern that raw video images could be observed by unauthorized viewers or stored for an inappropriate use. The acceptance of such technology could therefore be problematic, as it creates a sense of Orwellian "Big Brother" surveillance. Understanding user attitudes, intentions, and usage behavior towards lifelogging technologies, like such video-based technology at home, is thus essential for designing effective devices and applications as well as policies and practices for a successful implementation of supportive tools for an aging society.

This study aims at the evaluation of general perceptions and acceptance of cameras for lifelogging in the users' private environments. The critical aspect of privacy is examined and

compared from the perspective of individuals from two countries in order to explore whether this is a general phenomenon or whether cultural influences significantly affect perceptions of such technologies and applications.

Related Work

Lifelogging Technology Applications

In the area of *lifelogging technologies*, numerous technologies and systems have been developed in the last decades. The term "lifelogging" is usually interchangeably used with the terms "quantified self" or "self-tracking" and generally relates to a recording of everyday life and a digital self-tracking in different ways (Gurrin et al., 2014a; Selke, 2016). Lifelogging refers thereby to a real-time capturing of human life, using physiological and behavioral data to enable self-observation and self-reflection by data storage. Hence, lifelogging enables people to record their daily lives for versatile purposes and to a self-determined amount of detail (Gurrin et al., 2014b).

Probably the most common lifelogging technologies are wearable devices, such as smart watches and wristbands; widespread in the area of sports, wearable lifelogging devices are predominantly used by younger people. Such lifelogging applications have in common that they aim either at gamification or at the tracking and improving of health, in terms of animating and motivating physical activity as well as conscious nutrition (Schoeppe et al., 2016).

Another area of lifelogging is connected to the research fields of AAL, focusing on technologies and systems that are used for monitoring activities, detecting emergencies, and recognizing behavior deviations; in sum, these applications are designed to support and assist older and frail people in their everyday life. Rashidi and Mihailidis (2013) presented an overview of tools and systems in this area, indicating a broad range of applied technologies and sensors that reach from wearable to ambient-installed applications, all aiming at the collection,

processing, and analysis of the person-related data. Accordingly, the application potential of lifelogging technologies is extremely broad as they can be used in private and professional care settings, support an independent life, and enable assistance for diverse "users" (i.e., people in need of care, their families, and caregivers). Some other recent examples include the identification of changes in behavior and movement as indicators for dementia (Meditskos et al., 2018), monitoring of (dangerous) activities and movements to analyze the development of specific health conditions as well as detection of falls and emergencies (e.g., Mercuri et al., 2016; Postawka & Rudy, 2018), or recognition of social interaction (e.g., Wang et al., 2009, Crivello et al., 2018).

To enable these functions in home environments, different sensors and technologies can be used (Rashidi & Mihailidis, 2013), whereby infrared motion sensors, radio frequency identification, pressure sensors, smart tiles, magnetic switches, ultrasonic sensors, microphones, and cameras represent some of the most widely used elements. Especially video-based technologies with integrated sensors and cameras are well-suited to support older people as well as disabled or physically challenged individuals in their everyday life (Jalal et al., 2014; Climent-Pérez et al., 2019). Beyond the described technical potential and functionalities, it is essential to consider how future users perceive and evaluate such technologies in order to reach a sustainable adoption into their daily routines.

Lifelogging Technology Acceptance and the Role of Culture

For a successful implementation of novel technological devices, applications, or (ambient) assistive systems, the user-centered technology acceptance is a key indicator and the acceptance criteria are decisive predictors. Research with regard to the users' acceptance of assistive lifelogging technologies found that on the whole they were positively perceived and their capability in terms of support in older age was acknowledged (e.g., Peek et al., 2014; Gövercin et al., 2016; Offermann-van Heek et al., 2019).

Based on established technology acceptance models (e.g., Davis, 1989; Venkatesh et al., 2003), previous research has predominantly focused on perceived usefulness and perceived ease of use as key predictors for the behavioral intention to use and final acceptance of innovative technologies. In the context of assistive lifelogging technologies, which are mainly designed to be used by older adults to facilitate their daily routine within their homes, former research has identified additional motives and barriers that play a decisive role for acceptance (Peek et al., 2014; Jaschinski & Allouch, 2015). Among relevant motives, an autonomous life and the possibility to stay longer within one's own home environment are of major importance, especially for seniors and people in need of care. In the context of aging in place, older people frequently acknowledged safety-related functions, such as detecting emergencies and falls or alarms and notifications in case of emergencies (e.g., Demiris et al., 2008; Peek et al., 2014; Biermann et al., 2018). In addition, reminding functions, e.g., for medicine intake or appointments, were confirmed as benefits of using lifelogging technologies (e.g., Siek et al., 2010; Pollack et al., 2010). Reducing burdens for caring family members represents a further motive to use these technologies in older age (Lorenzen-Huber et al., 2011; Peek et al., 2014).

The use of lifelogging technologies, however, is also associated with negative aspects of aging. Hence, barriers related to topics such as privacy, data security, stigmatization, and usability are of high relevance. Studies in this research area revealed feelings of surveillance and invasion of individual privacy as well as feelings of isolation to be important concerns when people were asked about using assistive lifelogging in their daily routine (e.g., Sun et al., 2010; Steele et al., 2009; Wilkowska et al., 2015). In the context of privacy and data security, especially a perceived loss of control with regard to sensitive data or an unauthorized access to that data by third parties represented great barriers to the use (Lidynia et al., 2018).

Previous research also identified the respective application context (van Heek et al., 2016) and type of technology (Himmel & Ziefle, 2016) as further impacting parameters for the

acceptance of assistive lifelogging technologies. With regard to the latter, cameras were found to be least desired as assistive lifelogging compared to other technologies, such as motion sensors or microphones (Offermann-van Heek et al., 2019). Here, the following question arises: Are camera modifications, such as different visualization modes aiming for protection of privacy by displaying the image in different variations (a detailed description follows in Section 2.3), perceived more positively than conventional video cameras?

In addition to the technology-related parameters, it is important to consider different user factors decisively affecting the adoption of innovations (e.g., Sun & Zhang, 2006; Kowalewski et al., 2010). Even though, in recent years research and development are increasingly pursued in accordance with the user-centered design influenced by user diversity, the impact of culture is frequently disregarded. The *cultural background* of the users is perceived as an individual factor that may have moderating effects on technology acceptance (Sun & Zhang, 2006). Hofstede (1993) described culture as "the collective programming of the mind which distinguishes one group or category of people [nation] from another" (p. 89). Hofstede (2001) argues further that members of different nations carry 'mental programs' which are shaped during their childhood in the family and are later reinforced in schools and organizations they belong to. The resulting different values predominate among people from different countries. The framework of Hofstede's dimensions (Hofstede, 1980) has been particularly helpful in quantifying culture and integrating this construct into the research. In the context of technology acceptance, several cross-cultural studies brought the evidence that technology innovations have been differently accepted and implemented depending on the users' cultural background. For instance, Lee et al. (2013) showed significant cultural differences on mobile phone adoption patterns, differentiating between individualistic cultures (i.e., USA) and collectivistic cultures (i.e., South Korea). Other cross-cultural studies (Alagöz et al., 2011; Wilkowska et al., 2012) focused on the impact of cultural origin and user diversity on acceptance patterns of eHealth technology. The results revealed that besides differences in

user factors, such as gender and age, considerable differences exist in the acceptance of eHealth innovations between German, Polish, and Turkish participants, corroborating the importance of the consideration of the culturally shaped views. Moreover, Alagöz et al. (2010) have shown that the use of ambient and mobile electronic healthcare applications depends not only on their ubiquitous availability and technical feasibility, but also on their ability to be integrated into people's social dynamics with respect to cultural differences. Beyond these insights, there is hardly any knowledge about the cultural differences in technology acceptance related to using lifelogging technologies to support caring for older and frail people. However, family values have been shown to vary depending on different cultures, among others between German and Turkish participants (Mayer et al., 2012). In more detail, it was found that individualism was more relevant for German than Turkish participants, while for Turkish participants emotional and material interdependencies within the family were significantly more relevant. These differences provide evidence that also family structures, responsibilities in families, and understanding of caring in families might be influenced by the cultural background of people.

As the impact of culture on the acceptance of eHealth technology has been shown to be important for the adoption of technology-assisted home environments, it is likely to play an important role for economic and healthcare-regulating decisions in the long run. This applies to both the private area and health institutions, as demographic shifts and the associated shortcomings in the healthcare supply take place in many countries in the world. However, the cultural issues associated with user technology acceptance have received less attention than other moderating factors, such as gender, age, or experience. To close this gap and/or find empirical validation in this regard, the present study focuses on the influence that cultural background may have on the intention to use cameras for lifelogging.

Contextual Framework

The main focus of this study is to examine general perceptions and acceptance of video-based technology for lifelogging in domestic spaces, with particular attention to the cultural aspect. To test the effects of cultural factors, we empirically explore the topic with data collected from two contrasting cultures: Germany and Turkey. These two countries were chosen for several reasons: First, both countries differ in the political structure and their economies. While in the German parliamentary democracy, power is distributed among all citizens by intertwining and limiting the power of the different constitutional organs, Turkey's political system has been undergoing a profound change since April 2017, where the office of president was elevated to a central position of power, and the system of a parliamentary controlled government was abolished (Rumpf, 2017). In addition, the economic situation in the two countries differs significantly: The annual Gross Domestic Product (GDP) in Germany in 2019 was $3,846,591 million, leaving Germany placed 4th in the ranking of GDP of 196 countries taken under consideration. In comparison, the annual GDP of Turkey in 2018 was $771,274 million, which is about a fifth of that of Germany. The unequal proportions are also reflected in the rates referring to innovation and technology. According to the latest statistics of the Organization for Economic Co-operation and Development (OECD), not only gross domestic spending on research and development differs considerably in these countries (Germany: 3.1% vs. Turkey: 1% of GDP), but also the mobile broadband subscriptions (Germany: 85.1% vs. Turkey: 75.5% per 100 inhabitants) and access to the Internet in households (Germany: 94.8% Turkey: 88.3%). Furthermore, the ethical principles as well as different histories of both countries have shaped different philosophies and values, and the members of the particular nations were technically socialized in different ways—all these factors could considerably influence the acceptance of, and privacy awareness for, using lifelogging technologies. Second, according to a recent meta-analysis of Taras et al. (2012), Germany and Turkey represent two significantly different cultures and could thus provide revealing evidence about cultural impact on user attitudes

towards the use of cameras for lifelogging technologies. Third, the present study continues to a certain extent previous research on the acceptance of technologies in the healthcare area in these two countries (Alagöz et al., 2011; Wilkowska et al., 2012) and extends it to the use of video-based technology for lifelogging in AAL.

The technology used in the present study aims at supporting people in their private homes leveraging their autonomy through intelligent monitoring based on computer vision. Such assistive technology is meant to generate information about its users—especially persons with frail health—that allow to provide risk detection and support services, and has thus the potential to relieve to some extent the overburdened healthcare sector.

Padilla-López et al. (2015) proposed a visual privacy by context approach which aims at obtaining a trade-off between privacy preservation and intelligibility of the images being acquired. Thereby, privacy protection is achieved by different visualization modes, i.e., forms of the information disclosure that conceal sensitive information and provide different levels of protection according to the context. This context is defined by the observer, the identity of the monitored person (to retrieve the privacy profile), the closeness between the person and observer (e.g., relative, doctor, or acquaintance), appearance (dressed?), location (e.g., kitchen), and ongoing activity or detected event (e.g., cooking, watching TV, fall).

Eight different visualization modes were proposed with different levels of privacy preservation (Figure 1): raw image, blur, pixelating, emboss, silhouette, skeleton, 3D avatar, and invisibility.

Figure 1 about here

Each one of these modes allows the privacy protection of different visual characteristics of the person, i.e., colors, textures, shape, pose. Following this privacy-by-context approach, the monitored user can then choose one of these visualizations in any situation that could be

modelled by the context. This approach allows the user to grant different permissions to visualize the images to different people and according to the event that is taking place, as the user may abandon some of their privacy in favor of increasing security, if the event is important enough. These modes of visualization conceal different visual cues, offering different privacy levels (Figure 2).

Figure 2 about here

Adapted from the described approach, this paper has selected five representative visualization modes that preserve visual privacy at different levels. To increase comprehensibility and clarity for the participants, the terms of the visualization modes were slightly adjusted. For the "minimum" privacy level, an unchanged visualization mode, i.e., *real image*, was selected. For the "low" privacy level, the *pixel image* was chosen, while the *solid silhouette* was the representative for the "medium" privacy level. Regarding the "high" privacy level, both *skeleton image* and *avatar* have been selected. Integrating these modes enables to compare the evaluations of both modes for the "high" privacy level. As in the context of assisted living the preservation of poses is extremely useful for older individuals for detecting movements and behaviors, we decided against the integration of the visualization mode for the "maximum" privacy level (i.e., invisibility). In sum, five visualization modes—each representing another level of privacy protection (i.e., real image, pixel image, solid silhouette, avatar, and skeleton image; see Figure 3)— were taken for evaluation to investigate perceptions and acceptance of different modifications of cameras used for lifelogging in the assistive healthcare context.

Research Aim and Questions

This study examined preferences of different modes of information disclosure (visualization modes), referring to different criteria of technology acceptance in the healthcare context. In

addition, influences of two different cultures were researched to gain knowledge about the possible effects of technically differently socialized societies on the current perceptions and anticipated use of the video-based technology. The underlying research questions refer to the possible differences between German and Turkish participants and are formulated as follows:

1) Are there significant differences between these cultures in the general perceptions and behavioral intention to use lifelogging technologies? (RQ1)
2) Do German and Turkish participants significantly differ regarding acceptance criteria of the use of cameras for health-related purposes? (RQ2)
3) Do German and Turkish participants choose similar or different visualization modes of information representation for their own use, be it in the context of the accepted location or regarding the data access for the others, and which visualization mode is the most preferred one? (RQ3)

Method

Research Design

The study applied a two-step research approach, using qualitative and quantitative empirical methods. An important element was the comparison between views of technology users coming from different cultures. Since the results of previous cross-cultural studies suggest considerable differences in the perceptions and usage behavior of modern technologies, like the openness to use medical technologies (e.g., Alagöz et al., 2011), using social media for seeking and sharing health information (Li et al., 2018) or considering online self-presentation strategies (e.g., Boz et al., 2016), for the purposes of this research participants from Germany and Turkey were inquired.

In the first step, an explorative study in terms of focus groups was conducted, which aimed at gaining the participants' knowledge about, and the use of, lifelogging technologies in

general, as well as at getting first insights into their acceptance. The focus lied on healthcare-related technology, which is able to assist (chronically ill, old or disabled) people in performing their daily routines. German (n=6) and Turkish respondents (n=6) expressed their opinions, concerns, and wishes for the use of lifelogging technologies. Thus, the main objective of this qualitative study was to identify relevant criteria for the perception and acceptance of video-based lifelogging technologies from the perspective of German as well as Turkish participants. Two focus groups discussions (a German one and a Turkish one) were conducted with a total of N=12 persons. Each focus group consisted of representatives of both genders (50% female) and different technology generations (Sackmann & Winkler, 2013), ranging in age from 25 to 79 years (M=52, SD=14.8). The recruitment for the focus groups took place using private and professional contacts of the authors (all Turkish focus groups' participants lived in Germany at the time of the study) and the discussions were conducted in February 2019. The resulting opinions and ideas were predominantly used to conceptualize questions/items in a subsequent quantitative study in order to validate the findings in the second step. Besides, these qualitative statements on video-based lifelogging technologies expressed in the focus groups provided explanatory hints to discuss the quantitative findings of the online survey. The whole research design is depicted in Figure 3. As the findings of the focus groups study were fully incorporated in the conceptualization of the quantitative data collection, in this article we entirely focus on the outcomes of the online survey.

Figure 3 about here

Online Survey

The survey also collected opinions from German and Turkish participants (partly living in Germany) and evaluated both their general attitudes towards lifelogging technologies and the

specific acceptance aspects of visualization modes of videos in a healthcare-related context. Lifelogging cameras monitoring people in their daily lives were chosen as an application example for this purpose.

The questionnaire started with a short introduction of the topic and with demographic questions (e.g., age, gender, education). As the chosen application was meant to support health, the subjects were asked to specify what is their current health status (six-point Likert scale from "very bad" to "excellent") and at what distance from home their general practitioner is located (four-level scale from "under 1 kilometer" to "more than 10 kilometers"). Also, respondents answered if, and to what extent, they already use lifelogging technologies for health (prevention) and whether they have professional (working or have worked in the care sector) or private care experience with nursing care for relatives or other people around them (e.g., "I've never cared for a sick person before"; answer alternatives "yes/no").

Next, a short scenario introduced the participants into the video-based lifelogging technology which can be used for aged and/or (chronically) ill people to support them in their everyday life, for instance by the monitoring of health parameters, as a reminder of medication intake, to measure some body functions, and for the detection of emergencies, enabling in this way a longer staying in the own home. The participants were also informed that lifelogging can be used in the preventive context to get an overview of health (e.g., diet plan, physical activity, sleeping habits). In concrete terms, in the scenario the use of *cameras for lifelogging* was given as an example and represented the basis for the subsequent evaluation. In this evaluation, participants assessed perceived benefits (12 items; Cronbach's α=.95) and perceived barriers (12 items; Cronbach's α=.93), as derived from the findings of the previous focus group discussions, and they rated the subjective relevance of conditions/limitations of the use of such lifelogging cameras. This part of the survey was finished by a battery of four questions on technology acceptance in terms of the intention to use cameras for lifelogging in the own home

environment (Cronbach's α=.94). *All* ratings used six-point Likert scales ranging from min=1 ("I strongly disagree) to max=6 points ("I strongly agree").

Finally, the last part of the survey focused on more specific evaluations of aspects referring to the acceptance and future use of lifelogging cameras in private spaces. Using different modes of visualization of the monitored subject, i.e., real image, pixel image, solid silhouette, avatar, and skeleton image, participants evaluated aspects of acceptance, permission to access their personal data, and the location wherein they would or wouldn't allow the use of this lifelogging technology. More precisely, each mode of visualization was assessed by the respondents with regard to: (1) *Acceptance* in terms of behavioral intention to use it ("I can imagine using this recording mode at home."), perceptions of intrusion into privacy ("I find that the kind of visualization invades my privacy."), and optimal representation design ("I think that the way of visualization is optimal."); (2) Permission of *data access* for different stakeholders (i.e., physician, family members and friends); and (3) Accepted *location* of the use of cameras in private living space, i.e., living room, kitchen, bathroom. For the participants' ratings on the described items, again, the six-point agreement-scales as described above were used. At the very end of the survey, respondents were asked to choose among all visualization modes the most preferred one if they were forced to use this form of lifelogging technology.

The data collection took place in spring 2019. After pretesting, the German questionnaire was firstly translated into Turkish. In the next step, both versions of the survey were disseminated using professional and private contacts as well as through social media. To reach Turkish participants living in Germany and in Turkey, especially the Turkish version of the survey was circulated using the authors' private contacts.

Description of the Sample

A total of N=126 respondents completed the questionnaire. As this study aimed at a comparison of German and Turkish participants, those who either did not state their cultural background or

indicated other than the targeted nations (e.g., Albanian, Russian, Moroccan) were excluded from the statistical data analysis. Hence, *N*=118 participants are considered in the following analyses and the proportion of German (45%) and Turkish respondents (55%) was well balanced. All detailed characteristics of the participants are summarized in Table 1. In the following, only key characteristics are described in more detail.

Table 1 about here

The respondents of the study – for the greater part female (73.3%) – were adults aged on average *M*=32.2 years. The majority of them indicated a quite high education. Regarding their living situation and area, the majority of the participants reported to live together with their families or with another person, and they predominantly lived in urban areas. With regard to the health and care situation, the vast majority of our participants reported to feel quite well (88%). Still, almost 17% of them stated to suffer from a chronic illness, such as asthma, hypertension, thyroid hypofunction, or endometriosis, and only 3 persons (2.5%) reported to be sometimes dependent on the help of others. Asked for previous experience with care, a minority of the participants (15%) had professional experience in nursing, which means that they work or have worked in hospitals or other care institutions. With regard to private experience in care, almost 57% reported to have never cared for a person in need of care.

As a control, it was analyzed if the Turkish and German participants differed with regard to the sample characteristics. The analysis revealed that both groups of participants did not differ significantly with regard to demographic or health-related and care-related aspects. In contrast, the own significant difference was identified for the participants living situation ($p<.01$): The majority of the Turkish participants indicated to live together with their families, while a clearly larger part of the German sample indicated to live with another person.

Research Variables

In this study, we examined the influence of culture on the (anticipated) usage behavior of available lifelogging technologies in the healthcare-related context. Therefore, the *cultural background* of the participants served as an independent variable and was used for comparison between German and Turkish respondents. Moreover, the five *visualization modes* (as depicted in Figure 3), were taken as independent variable into account in the following statistical analyses when examined for the participants' preferences and acceptable output formats of the lifelogging camera.

As dependent variables, general attitudes towards the use of lifelogging technology and specific acceptance criteria of video cameras were examined. The *general perspective* on the use of lifelogging technologies was, firstly, queried through a general intention to use lifelogging cameras for both oneself (e.g., "I would like to use camera technologies for lifelogging.") and family members (e.g., "I'd want older family members to have such a system in their house."). Secondly, the general attitude is shown here by means of perceived importance of limitations/conditions of use of this technology (e.g., "The camera should have a filter to make the images anonymous."; "Conversations and noises must not be recorded.").

On a more specific level, *acceptance criteria* of the lifelogging cameras were taken into account as dependent variables, including (1) assessments of the different visualization modes with regard to the intention to use them, intrusion into privacy, and perceptions of optimal information representation design. In addition, (2) access permissions to data resulting from different visualization modes was queried, considering the physician/family doctor, family member(s), and friend(s). The study used also (3) accepted locations for the use of lifelogging cameras, contrasting living room, kitchen, and bathroom as places with different levels of the individuals' intimacy. In a final step (4), participants were asked to choose the most preferred visualization mode ("Which visualization would you most like to use yourself?").

Results

For statistical analyses of the influence of the cultural background on perceptions of using lifelogging technology from the general perspective, one-way between groups analyses of variance (ANOVA) were applied in this study. For effect sizes, eta squared (η^2) was calculated. If the assumption of homogeneity of variance was violated, Welch tests are reported to verify the equality of group variances. For calculations of differences in the assessments of specific acceptance criteria of the designated visualization modes, repeated measures analyses of variance (rmANOVA) were used, and the significance value in the multivariate tests was taken from Wilks' Lambda. In addition, the influence of the subjects' cultural background on the acceptance evaluations and a possible interaction between the two factors were analyzed. If the assumption of sphericity was violated (Mauchly's Test of Sphericity < 0.05), Greenhouse-Geisser correction was used. In the following, means (*M*) and standard deviations (*SD*) are reported for descriptive analyses. The statistical significance (*p*) was set at the conventional level of 5%.

General Perceptions of Cameras as Lifelogging Technology (RQ1)

The first research question refers to the attitude towards cameras for lifelogging in general. Thus, in the first step, we examine how Germans and Turks basically evaluated the perceived benefits and barriers of using the camera technology in private environments. After that, we take a look on their intention to use the cameras and analyze the perceived relevance of the usage conditions for this technology. Overall, we examine whether these perceptions significantly differ in the two cultural groups.

After introducing the lifelogging camera and its potential for assisted living, participants evaluated the connected *benefits* (e.g., enabling fast access to the health data, reducing dependency on others, increase in autonomy, relief of caring relatives, enabling fast reactions in emergencies, etc.) and *barriers* (e.g., invasion of privacy, the supervisory character of the

technology, concerns about the personal data, substitution of human care by technology, etc.). To get an overall impression of the users' general perceptions on the lifelogging technology, scales on respondents' opinions regarding the perceived benefits and barriers were built and analyzed; all relevant statistics are summarized in Table 2. *T*-tests for independent samples revealed a main effect of the cultural background on the evaluations of benefits, demonstrating that the resulting opinions of Turkish participants were on average significantly more positive than those of the German respondents. As opposite to that, for the scale of perceived barriers the impact of culture was not decisive: All respondents agreed on the disadvantageous aspects of the camera use—especially the ones of privacy invasion and data security—and in most cases the German respondents reached higher means than the Turkish participants. A detailed analysis of these perceived motives and barriers resulting for the use of lifelogging cameras for assisted living was carried out in a study of Offermann-van Heek and colleagues (2020).

In addition, one-way ANOVA revealed a main effect of cultural background on items referring to the *intention to use* cameras for lifelogging. The statistical details are summarized in Table 2. The general attitude, especially among the German participants, was quite reluctant which is clearly recognizable in the resulting low means (Figure 4). In more concrete terms, the participants of both cultures differed significantly regarding their intention to install the cameras at the own home: Germans showed significantly lower intention to do so than Turks. The results regarding the usage concept were similar: In the intention to use cameras for lifelogging participants of both nations showed rather rejecting engagements, although the Germans indicated significantly more rejective attitude than Turks. The greatest effect size, however, resulted for the intention for (older) family members to use the technology in their living space; here, Turkish respondents showed on average a more affirmative attitude than the German ones. Summarizing, these results attest that German and Turkish (potential) technology users significantly differ in their general intention to use cameras for lifelogging.

Figure 4 about here

Table 2 about here

In the context of general perceptions of lifelogging cameras, the study additionally examined the *relevance of perceived limitations* for the use of lifelogging cameras. As depicted in Figure 5, the main effect of the cultural background was noticeable; for reasons of space, the description is only limited to the significant differences in opinions of German and Turkish participants (for statistical details see Table 2). According to the resulting effect sizes in the calculated ANOVAs, respondents' opinions of both nations were most divided regarding the duration of the accessibility to the camera recordings: While German participants attached relatively little importance to this aspect, Turkish respondents perceived it as significantly more important. Further, both cultures attached little importance on lacking restrictions of the technology, whereby Germans reached lower means than Turks. Conversely for this statement, this means that lifelogging cameras should definitely have regulatory restrictions to reach a higher user acceptance. In addition, whereas all participants attached great importance to a clear definition of data protection provisions, the resulting means for both countries still differed significantly, being for Germans considerably more important than for Turks. Significant differences resulted also for the permission of recording the environment with Turkish respondents perceiving this aspect as more important than the German ones.

Figure 5 about here

Beyond that, German more than Turkish participants paid attention to the possibility of turning off the camera, no recording of conversations and persons as such, and to the accessibility of the camera shots only for a short period of time. At the same time Turkish users perceived the anonymous recording on average as more relevant than German ones. Even though the lastly mentioned differences were not statistically significant, these results expose overall differing general perceptions of the lifelogging technology use and suggest, therefore, consideration of varying demands which result from the different cultural backgrounds.

Evaluation of the Visualization Modes (RQ 2 and RQ3)

In the next step of the statistical analyses, the study dealt with questions, like which visualization mode is the most accepted one, and, do German and Turkish participants choose similar or different visualization modes for lifelogging video cameras for their own use? To answer these questions differences between the five previously presented visualization modes (i.e., real image, pixel image, solid silhouette, avatar, and skeleton image) as well as the influence of the cultural background on the preferences regarding different acceptance and usage criteria were statistically examined using repeated measures ANOVAs. All relevant statistical parameters are summarized in Tables 3–5.

This section deals firstly with general perceptions of the visualization modes under consideration of acceptance criteria. Secondly, the same visualization modes are assessed with regard to permissions of personal data access. Thirdly, the evaluation of the camera visualizations takes place depending on the accepted location. And fourthly, an overall preference of visualization modes is evaluated.

Acceptance Criteria for the Use of Cameras for Lifelogging (RQ2)

Behavioral intention to use a technology is one of the most validated criteria for acceptance in accordance with the Technology Acceptance Model (Davis, 1989). By the evaluation of each

visualization mode, the participants were asked whether they can imagine using a particular recording mode in their private four walls. A rmANOVA with a Greenhouse-Geisser correction determined no significant differences between the camera visualizations in this context (see Table 3), but a significant interaction effect was found when considering the cultural background of the subjects. The resulting means are depicted in Figure 6. While Turkish participants ascribed slightly higher means to the real and pixel images, Germans rather intended to use the solid silhouette, avatar, or skeleton image. According to the low means of agreement (<3.5 out of 6), it is yet recognizable that all respondents exposed overall rather reluctant attitudes regarding their intention to use lifelogging cameras at home, independently from the form of the representation.

Table 3 about here

Figure 6 about here

As a further aspect for the technology acceptance, the perceptions of the *invasion of privacy* were chosen. The resulting main effect of the visualization modes is presented in Figure 7 and Table 3: The real image was perceived as intruding most into the privacy of the participants and was followed by pixel image, while solid silhouette, avatar, and skeleton image were evaluated rather as not privacy-intrusive. According to the effect size, there is a strong influence of the visualization mode on the perceptions of privacy violations, while the cultural background does not affect these in a significant way.

Figure 7 about here

In addition, to get opinions about an *optimal representation design* of the lifelogging camera recordings, participants were asked to choose one among the five visualization modes. rmANOVA determined that the resulting means for optimal design significantly differed between the visualization modes (see Table 3). Additionally, data revealed a significant interaction with the cultural background. Even though these effects are small, as pictured in Figure 8, it is visible that the real image reached the highest average evaluations among the other representations. This result refers to the assessments of the Turkish respondents, who reached a significantly higher mean of M=3.5 (SD=1.5) in comparison to the German part of the sample (M=2.5, SD=1.1). Thus, also this aspect of acceptance implies that the different camera settings are not perceived as an optimal representation of the information obtained.

Figure 8 about here

Summarizing, the analysis of the acceptance criteria exposed among the participants a rather reluctant attitude towards the concrete modes of information visualization, disclosing at the same time a decisive influence of culture on these perceptions.

Permission of Data Access Using Lifelogging Cameras (RQ3)

In addition to the acceptance criteria, the participants evaluated the extent to which they would grant access to their thus obtained personal data to different stakeholders. As this has been asked in the health-relevant context under the assumption of different degrees of privacy/intimacy in relation to disclosure of such data, we decided to map the permissions for the physician/family doctor, family member(s) and friend(s). In the following, the influence of the visualization modes in combination with the cultural background is statistically examined with regard to the *permission of the data access*. All relevant statistical values are presented in Table 4. To make the results reasonable, the figures in this section are limited to the interactions between the

visualization modes and the countries, while the main effects of visualization are verbally described.

Table 4 about here

The calculation of rmANOVA revealed that visualization modes significantly differed with regard to the disclosure of the data to the *physician*. The real image of the lifelogging camera achieved the highest permission, but also the other visualization modes reached means that point to more positive than negative perceptions in this regard. As depicted in Figure 9 (left), a significant interaction with the cultural background was found: The access of personal data for the physician was mostly accepted by Turks using the real image, followed by the pixel image; the avatar image reached the lowest mean. In the German sample, on the other hand, the variation between the resulting average values was considerably smaller.

Figure 9 about here

A comparable statistical calculation with regard to the data access permission for *family members* revealed again a highly significant influence of the visualization modes and a significant interaction effect in combination with the cultural background (see Table 4). According to the values of eta squared, the effects are stronger than the previous results and the real image reached the highest mean among the other representation modes. Figure 9 (in the middle) depicts the interaction effect: Turkish participants accepted the real image the most when allowing family member(s) access to their personal data, while the least preferred was the information representation using the avatar. As opposed to that, in the German group the results did not indicate one clear preference for any visualization mode in this regard.

Finally, mrANOVA including *friend(s)* as recipients of the shared data in the analysis was performed and showed that the visualization modes—also in the interaction with the cultural origin—significantly affected the permission of access to the personal data. As summarized in Table 4, the low means reached not even the middle of the scale, making evident that overall the visualization modes are not well accepted as a medium to share their private (healthcare-related) data with friends. With the low mean of M=2.8 (SD=1.7), avatar gained the highest agreement for sharing their data with friends among all examined visualization modes. The interaction with culture makes this result event clearer (Figure 9 right): For the representation in the form of an avatar, the Turkish participants reached the highest average value.

If it comes to allow access to personal (health) data recorded by lifelogging camera, the highest willingness resulted for the family doctor, followed by the family member(s). In the three examined cases, the cultural background played a significant role with Turkish participants posing considerably more differential attitudes toward the visualization of the data to be shared than the German respondents.

Accepted Locations in Private Use of Lifelogging Cameras (RQ3)

Examining an accepted use of lifelogging cameras, it is also a good choice to explore which locations are perceived by the participants as admissible. Choosing the locations for the technology in private spaces, the grade of the perceived privacy was varied (living room, kitchen, bathroom). In the following, the influences of the visualization modes in combination with the cultural background are statistically analyzed taking the accepted locations into account. All statistical measures are presented in Table 5 and the interacting effects are depicted in Figure 10.

Table 5 about here

In the first step, opinions about video recording in the *living room* were examined. A repeated measures analysis of variance revealed a main effect of visualization modes and an significant interaction with the culture, but the effect sizes indicate only small effects. For the living room, the real image gained overall the highest approval and this was especially pronounced by the Turkish participants, who reached significantly higher average values than German participants. All resulting means are depicted in Figure 10 (left).

Figure 10 about here

In the second step, the statistical analysis referred to the *kitchen* as location for the lifelogging camera. Here, the visualization modes differed considerably, but the differences were also significantly influenced by the participants' origin (the relevant statistical parameters are summarized in Table 5). While the perceptions of the German participants hardly varied between the visualization modes, oscillating around the middle of the scale and indicating a quite neutral opinion, the use of lifelogging cameras in the kitchen was quite accepted in the Turkish group as a real image, but unacceptable as an avatar. The details are depicted in Figure 10 (middle).

This tendency turns around in relation to the *bathroom* as an accepted location for using lifelogging cameras: Here, especially the avatar reached the highest value on the agreement scale, significantly differing from the other visualization modes. In the interaction with the cultural background, the differences are clearly accounted for by the perceptions of the Turks. In contrast, in the German part of the sample the means did not differ significantly. The statistics for the main and the interaction effect are presented in the lower part of Table 5 and are depicted

in Figure 10 (right). Nonetheless, respondents basically did not accept the technology in bathroom, independently from the mode of the information representation.

Summing up, the location of the lifelogging cameras in the private space plays an important role in the acceptance, depending on the perception of privacy. None of the examined locations for lifelogging cameras at home gained an enthusiastic approval from the survey participants. However, while open spaces like living room or kitchen are slightly accepted—or at least not rejected—placements for the monitoring technology, an intimate place as the own bathroom is preferably rejected. The only signs for a certain willingness to use it is the condition that the person recorded is unrecognizable (=avatar mode). Germans and Turks significantly vary in their perceptions, and the latter have much more variable settings to the visualization modes.

Preference of Visualization (RQ3)

In the final step, participants were asked to choose among all five camera visualization modes the one they would prefer most if they were forced to do so for health reasons. The idea was, especially after the prior extensive dealing with this topic from different perspectives (i.e., criteria of acceptance, data sharing, location), to gain knowledge about the overall most accepted information visualization when using video cameras for lifelogging, and to examine if there are culturally-based differences in this regard.

The results for the German and Turkish respondents are depicted in Figure 11. Two of the presented visualization modes stand out: the real image and the skeleton image. Turkish participants' preferences referred to both modes, whereby the real image gained with almost 57% the highest attention in this group. The skeleton image reached with 29.4% only a half of the amount. Interestingly, in the Turkish part of the sample the mode solid silhouette was not voted for at all.

The preferences for lifelogging cameras in the group of German respondents were not very unambiguous. The highest preference resulted for the skeleton image (42.5%) as the mode in which they would wish to represent their health-related information. But the preferences were distributed much more evenly among the remaining visualization modes.

It can be assumed that the resulting preferences in the examined culture groups depend on the perceived contextual privacy. However, both examined groups differ in the degree of sensitivity to the ethically acceptable abidance of privacy when it comes to the visibility of their personal data recorded by lifelogging camera technology.

Figure 11 about here

Discussion

The aim of this article was to examine the anticipated acceptance and willingness to use video-based technology for lifelogging in private environments. As this technology bears especially in the context of healthcare a great potential for older, disabled, and (chronically) ill persons as assistance in their everyday lives (Rashidi & Mihailidis, 2013), it is beneficial to understand to what extent people are ready to use it and which conditions have to be fulfilled to awaken their intrinsic motivation to do so; be it for themselves or for (close) family members. The question of acceptance and the resulting successful adoption of such assistive technologies in private home environments reaches thereby beyond the bare usability and the users' intentions. Much more, decisions about the real use are frequently influenced by deeply anchored cultural and societal phenomena, which are more difficult to determine. This explorative study focused on such cultural influences and shows how different opinions about a controversial—due to its invasive nature regarding personal privacy—yet highly supportive technology can be.

General Attitudes Towards Cameras as Lifelogging Technology

Regarding the general attitudes towards cameras for lifelogging (RQ1), the outcomes are insightful and show that the intention to use this technology for assisted living is culturally shaped and significantly different in German and Turkish respondents; similar findings resulted already in former studies (e.g., Alagöz et al. 2010; Wilkowska et al., 2012).

Overall, the attitudes were rather reluctant, which corroborates previous research in this area (Himmel & Ziefle, 2016). Especially German participants voiced reserved opinions with regard to using the video-based technology in their private environments, rejecting all statements that referred to the intention of its use. The German participants did not differentiate between the own use and the use by others: This technology seems to encroach too much on their personal privacy and its use is perceived as not offering enough benefits over the perceived barriers. In short, the cost-benefit calculation does not work out properly for the German group. The resulting average values for the perceived relevance of limitations when using lifelogging cameras confirmed this implication. German participants perceived a clear definition of data protection provisions and a permanent possibility of turning off the camera as very important in addition to aspects, like anonymizing filters, limited accessibility to the recordings, and non-recording of conversations; these findings are in line with other studies (e.g., Lidynia et al., 2018; Wilkowska et al., 2020). The importance of appropriate (legal) restrictions for this lifelogging technology substantiates the conclusion about the reluctant attitude of Germans towards using cameras in private environments.

Turkish respondents were not very enthusiastic about the use of cameras for lifelogging, either. Their neutral answers suggest neither full agreement nor rejection regarding the installation and use of such a video-based technology at their own homes. This rather reserved attitude of Turkish respondents regarding technology use for health-related purposes has already been identified earlier in this field of research (Alagöz et al. 2011, Wilkowska et al.,

2012). Even though the present findings significantly differed from the outcomes of the German group, the most remarkable difference was observed in the opinions on using cameras for older family members in frail health. As opposed to their German counterparts, Turkish participants evaluated this aspect significantly higher, favoring that older family members use such assistive technology in their homes. This result shows that caring for older family members has obviously a higher priority in the Turkish families and people are therefore more willing to accept certain invasions of their privacy. Nevertheless, results suggest that this is true for others, but not for themselves. One reason for the higher priority of caring for older family members could be that family values are also different in the two discussed cultures (Mayer et al., 2012); hence, the prevalence of emotional and material interdependence within the family may lead to a higher willingness to support older family members in need of care. This possible explanation is additionally supported by the identified differences in the living situation between both countries: A high majority of the Turkish participants indicated to live together with their families. In contrast, the German respondents indicated to live predominantly together with only one other person—most probably the partner. These differing family structures of both countries support the argument that caring for their family (resulting in a higher willingness to use video-based technologies) is more relevant for the Turkish than the German participants.

Regarding the conditions for using the technology, the option of deactivating the camera as well as clear regulations for data protection are very important for the Turkish participants. So far, the results corresponded with those of the German part of the sample. The greatest difference between the two cultures concerned the duration of the accessibility of camera recordings: While it was important for Turkish respondents to allow access to the recordings for a minimum of two years, German participants clearly rejected this option. It is well conceivable that this difference in view may again be traced back to the different understanding of caring for frail family members. The concern for privacy is greater for the German

respondents, whilst the Turkish users may prefer to ensure that the recorded material can be used over a longer period of time.

Given these findings, we can clearly answer the first research question (RQ1), stating that between the investigated cultures significant differences exist in the general perceptions and the behavioral intention to use video-based technology for lifelogging in the living space. Questions pertaining to the concrete reasons for these differences and the specific influences inducing them cannot be satisfactorily answered on the basis of the information gathered in this study, but they should be specifically addressed in future research. Presumably, the underlying aspects shape a mixture of differing technical socialization paired with the diverging ideas of the family cohesion [e.g., family values as described by Mayer et al. (2012)] up to different political situations and jurisdiction in the respective countries. However, this finding allows the conclusion that for a successful implementation of such a lifelogging technology different levels of information communication, varying strategies promoting the product, and varying widths of explanatory approach have to be applied in these two countries.

The "How to" of Lifelogging Cameras in Home Environments

Moving on to a deeper level of the video-based technology acceptance (RQ2), we investigated the culturally shaped views on it in a narrowly defined true-to-life scenario with regard to concrete neuralgic aspects (i.e., intrusion into personal privacy, access authorization to the recorded data, location). For the preferences of information visualization, five modes corresponding to different degrees of privacy were used, and special attention was paid to the cultural influences on the opinions of the potential users.

According to the presented results of acceptance criteria used for the different visualization modes, it can be concluded that the overall intention to use cameras in one's own home is rather low, independently of the way information is presented. Still, Germans and Turks significantly differ in their preferred visualization modes. If they used the cameras, Turkish

participants would mostly prefer the real or pixelated image. In contrast, Germans would intend to choose more anonymous forms of information presentation, i.e., skeleton, silhouette, or avatar. This result is also mirrored in the question referring to perceptions of an optimal design of the visualization. Here, the influence of cultural background once again plays a relevant role and shows similar preferences in the two nations. As the participants were not directly asked to reveal the reasons of their evaluations, we can only assume the underlying motives for this outcome. A possible explanation refers to the concerns regarding one's own privacy and the security of the personal digital data. However, this is only an assumption. In order to find the real reasons and motives, future empirical research is necessary. Nevertheless, our study provides the evidence that the resulting perceptions of intrusion into privacy are *not* affected by the cultural background. On the contrary, the main effect applies to the entire sample and shows that the real image, followed by the pixelated image, are perceived as the most invasive forms of information visualization. Accordingly, the intention to use the cameras for lifelogging among German participants seems to be well-founded by these fears. But, why did the Turkish respondents choose the visualization modes that in their opinion violate their personal privacy the most? This finding leads to the conclusion that, in addition to the fears of privacy invasion, other important factors influence the intention to use lifelogging cameras and, therefore, the acceptance of their use in domestic environments—at least in one of the cultural groups investigated here.

The situation-dependent aspects of technology-enhanced environments may trigger different privacy concerns for different people (Psychoula et al., 2017). In addition to the above mentioned criteria, our study therefore examined another aspect assumed to be decisive for the use of cameras in private environments—the accepted *location* (RQ3). Corresponding with the relevant literature in the area of AAL (Ziefle et al., 2011; Himmel & Ziefle, 2016), different degrees of privacy were defined, referring to the permitted location of the technology: living room, kitchen, and bathroom. The findings suggest the following: 1) Overall, the degree of

acceptance of the location oscillates between neutral and negative opinions, as the means do not exceed values of 3.7 of 6 points, which indicates that these are just across the middle of the whole scale. Here, the application of the lifelogging technology gains such a neutral advocacy for living room and kitchen, whereas the use in the bathroom is not accepted. Moreover, 2) closely related to this is the resulting main effect of the visualization modes, which shows that in the two "less private" rooms—living room and kitchen—the real image is preferred over the other visualization alternatives, while in the bathroom, as the room with the highest level of the required intimacy, the avatar gains the highest popularity. And 3), in all three living spaces the influence of the cultural background is noticeable: Germans maintain their neutral to rejecting attitudes towards the different modes in the three locations, while Turks differentiate much more between the visualization modes, preferring the real mode for the more public spaces in their homes and choosing the avatar for the visualization of their data in the bathroom.

To derive further knowledge regarding the acceptance of cameras for lifelogging the willingness of personal *data sharing,* i.e., data access for others, has been scrutinized (RQ3). Since the study emphasized the healthcare-related context, this aspect aimed especially at elders and persons with (chronic) illness or physical impairment(s). The outcomes permit the following conclusions: The general attitude toward sharing of data gained from the lifelogging cameras is neutral towards physicians and family members, and rather reluctant towards friends. Apparently, for the relevant stakeholders in one's own life, such as relatives and medical experts who may be essential for the own well-being, the real image is most preferred, even without any deeper motivation to use the technology. The preferences are different in relation to the data access for friend(s): Here, not only the acceptance and willingness of data sharing is lower (means below 3 of max. 6), but also the preferred visualization mode is the avatar, which obscures much of the real representation of the user. In addition, the cultural origin again takes his toll: For Turkish participants, data sharing with the physician and family members using the real image is quite well accepted. Interestingly, in this cultural group it is

striking that the avatar is not an option for data sharing with family members, but this visualization mode gains the highest interest for sharing the data with friends. In the German group, the assessments are comparable for all five visualization modes and the resulting means for data sharing with the doctor and the family members lie in the neutral zone (i.e., around the middle of the scale). The option of data sharing with friends is generally rather rejected and no specific preferences for the particular modes result in the German group. Hence, it can be concluded that the camera use recommendations for the information visualization for data sharing would be easier to define for Turkish users in comparison to the German users.

Eventually, the question about the overall preferred visualization mode (RQ3) brought quite unambiguous results for Germans, who mostly preferred the skeleton mode as a favorite information representation. Turkish respondents mostly preferred the real image, but many have also chosen the skeleton as an imaginable mode of visualization. According to these findings, the last research question leads to the following conclusion: If they had to use lifelogging cameras, German and Turkish participants would choose different visualization modes of camera for their own recordings, and this both in the context of the accepted location and with regard to the data sharing. However, without any privacy-sensitive context the preferences for information representation of camera recordings in the own home did not vary so much between the individuals of different cultures: Germans opted for a more anonymous visualization mode (skeleton) and Turks predominantly chose the real image, but perceived the skeleton image as a good alternative.

Summing up, the Turkish respondents showed more openness for this innovation, at least for their family members, while the German participants seemed to be more worried about their privacy violations. The findings of our study confirm the significance of cultural influences that affect the technology's acceptance (Alagöz et al., 2011, Lee et al., 2013) and enable to derive some recommendations related to the future design of video-based lifelogging

technologies. Drawing from the evaluated acceptance conditions, product designers and developers should compulsorily integrate the opportunity to turn off the lifelogging cameras. Even if this function has to be defined and individually discussed in cases of severe or risky health situations, the opportunity should be basically available to the users. Another consistent requirement of the users applies to the importance of clearly defined data protection provisions. Future users should be transparently informed about which data are specifically recorded, in which way and where the data are recorded, and how long the data will be stored. The consideration of these wishes and opinions of potential users in the future design, development, and marketing of video-based lifelogging technologies will increase the probability of acceptance and adoption in everyday life.

Limitations and Directions for Future Research

Although the results are insightful and allow meaningful conclusions on the way to accepted video-based technologies in domestic environments, there are still some shortcomings of the presented study and many supplementary aspects that need to be addressed and could help to gain further knowledge in the future studies.

An enhancement of the picture quality of the camera visualizations which are shown to the survey participants represents one such improvement for future studies. From the respondents' comments and critical points after filling in the questionnaire, this issue is now known and should be accordingly addressed in the future. In this context, also a different presentation form of the technology could complement and beneficially affect the users' opinions. In our survey, we used pictures of a person in the five different visualization modes for the information presentation. However, it is conceivable that a presentation of an everyday activity in a short video sequence could profoundly change the opinions and the perceived potential of the technology due to a more real usage setting.

In addition, it is important to consider that even though this explorative study at some points identified evaluation patterns and relationships, the underlying reasons and motives which would adequately contextualize the cultural aspect and make the conclusions more generalizable, were not yet sufficiently addressed. Especially regarding the participants' understanding of caring for older/disabled family members and their dealing with responsibilities in families, future research should focus on the identification of relevant perceptions, reasons, motives, and ideas in the context of aging and care. Considering these aspects, future studies should also directly ask why the specific technology (or type of visualization) was (not) chosen or accepted by participants. This way, the here discussed explanations and assumptions could be validated and better substantiated.

A further weak point of the data collection referred to the fact that a big part of our sample came from cities (around 80%). The place of residence may have a decisive impact on the perceptions and thus adoption of the technology, as the infrastructure in cities is significantly different from that in rural areas (e.g., availability of medical professionals). In future studies, more participants from countryside are needed to get more representative outcomes in this regard.

Not least, the comparison of solely Turks and Germans is only exemplary and not sufficient to draw compulsory conclusions regarding the cultural differences in the adoption of the described technology. A major added value in this context would compare perceptions of further cultures, who may be more exposed to video recording in everyday life (e.g., mass surveillance in the United Kingdom). Hence, further nations and cultures must be investigated to continue the research and derive more concrete conclusions.

Conclusion

Outcomes of this study provide insights referring to the differences of German and Turkish (potential) users in the acceptance and intention to use video-based cameras for lifelogging in

domestic environments. Understanding the users' expectations and demands in this regard enables a better adaptation to the respective requirements and, therefore, perhaps a more successful implementation of such assistive technology in people's homes. For a more far-reaching perspective, this technology—used in retirement homes or rehabilitation institutions—could support the overburdened healthcare system or even relieve it to a certain extent. Considering the knowledge about the cross-cultural differences, better tailored arrangements could enhance existing shortcomings also beyond the borders. Therefore, deepening research in this area is promising and allows for advancements as well as an optimal strategy to suit the cameras for assisted living to the needs of the future users.

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Figure Captions

Figure 1: Visualization models (Padilla-López et al., 2015).

Figure 2: Grouping of visualization models according to the visual cues that are concealed (Padilla-López et al., 2015).

Figure 3: Research design of the study.

Figure 4: The general intention to use lifelogging cameras in the German and Turkish sample.

Figure 5: The relevance of limitations/conditions of the use of lifelogging video cameras; under the red line the differences between German and Turkish participants are statistically significant (item descriptions are marked with *).

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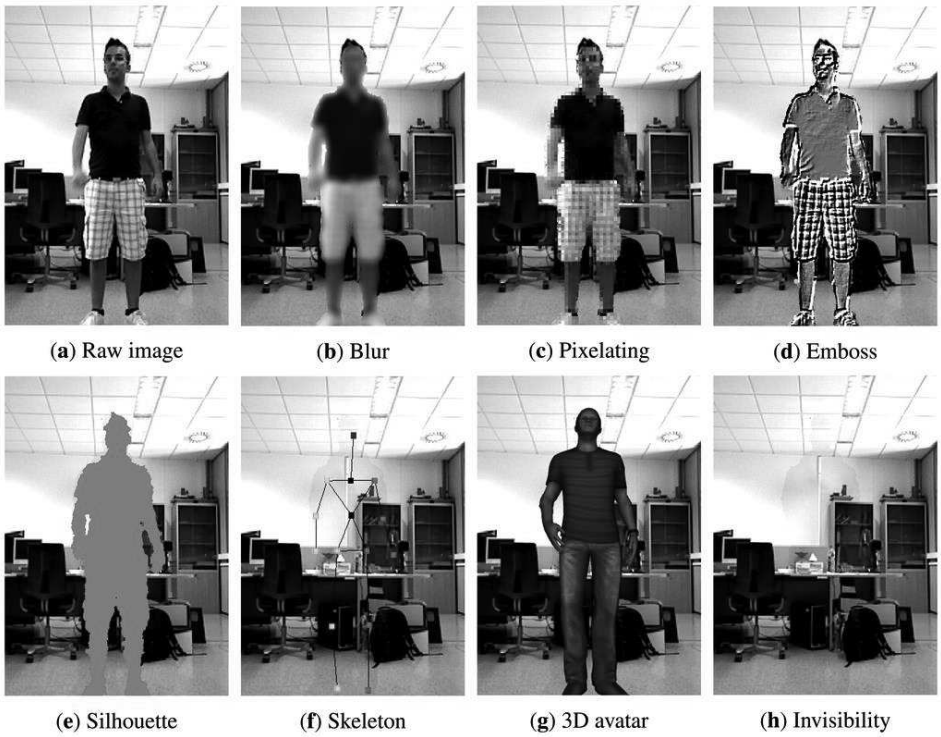
Figure 8: Main effect of the visualization modes (right) and an interaction effect of visualization and cultural background (left) on the perceptions of optimal representation design.

Figure 9: Interaction effects of visualization and cultural background on the permission of data access for the physician (left), family members (middle) and friends (right).

Figure 10: Interaction effects of visualization and cultural background on the accepted location of the camera use in private living spaces: living room (left), kitchen (middle) and bathroom (right).

Figure 11: Ultimate preferences of the visualization modes resulting for Germans and Turks.



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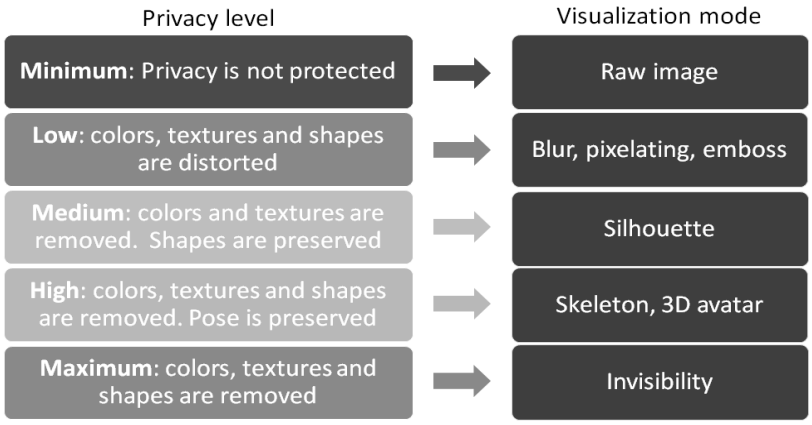


Figure 2: Grouping of visualization models according to the visual cues that are concealed (Padilla-López et al., 2015).

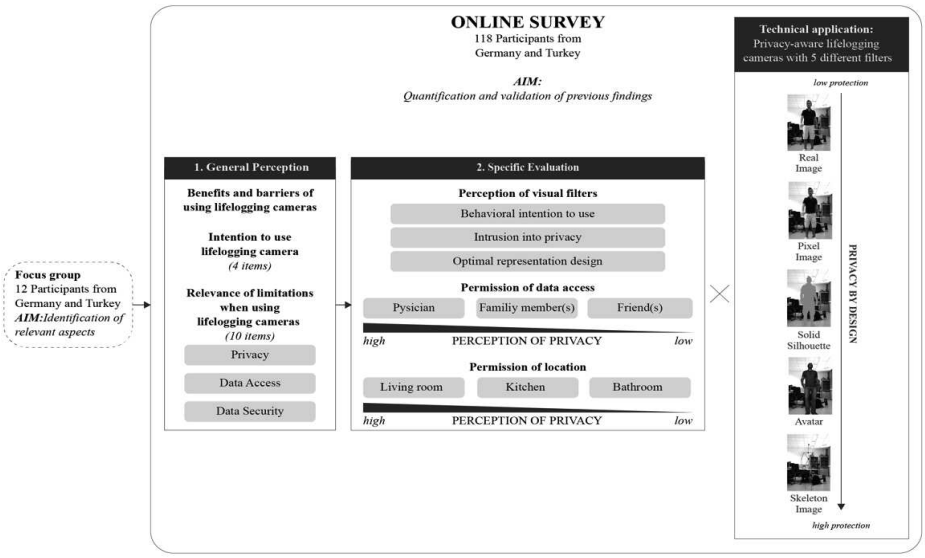


Figure 3: Research design of the study.

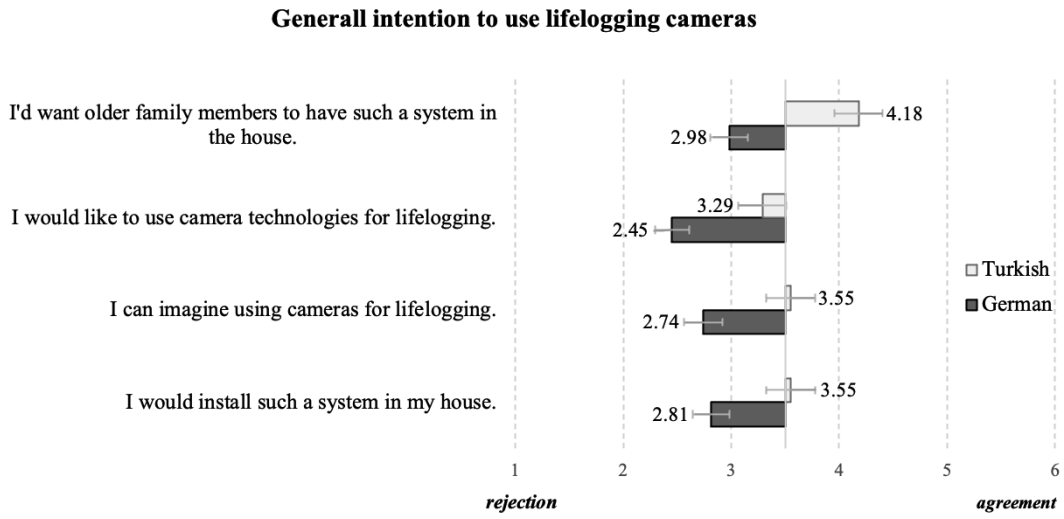
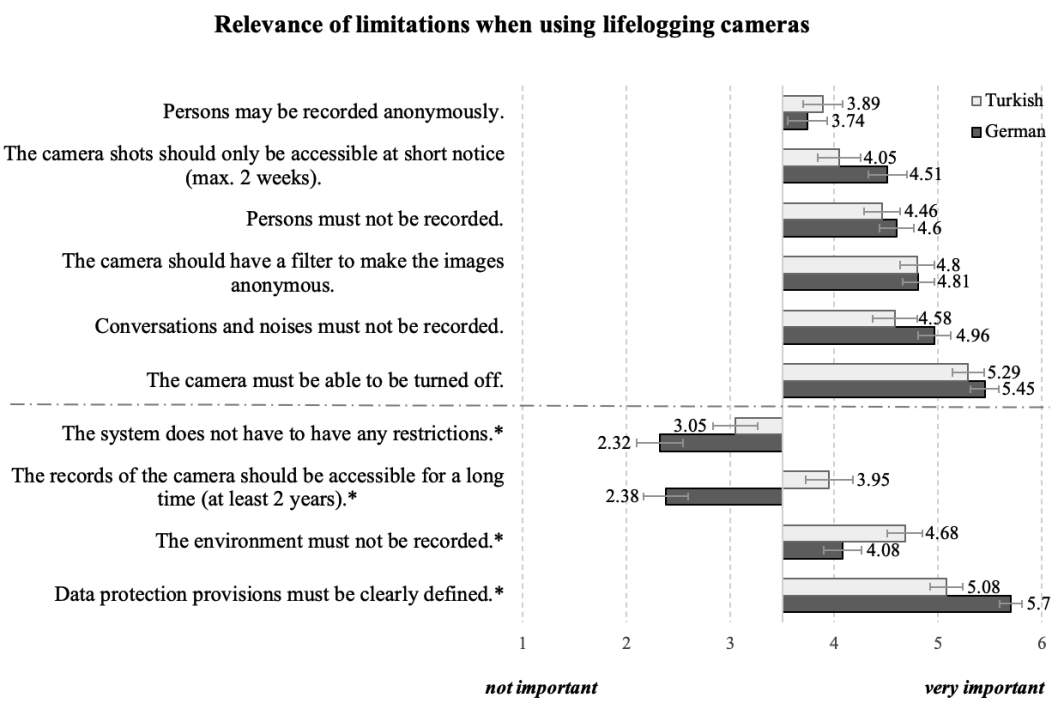


Figure 4: The general intention to use lifelogging cameras in the German and Turkish sample.



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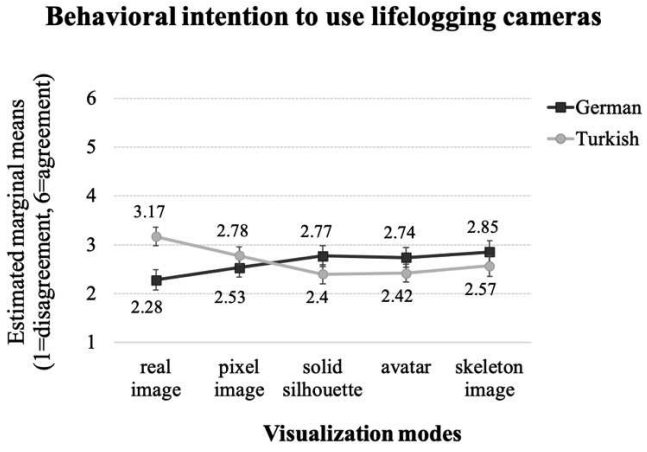


Figure 6: Interaction effect of visualization and cultural background on the behavioral intention to use lifelogging cameras.

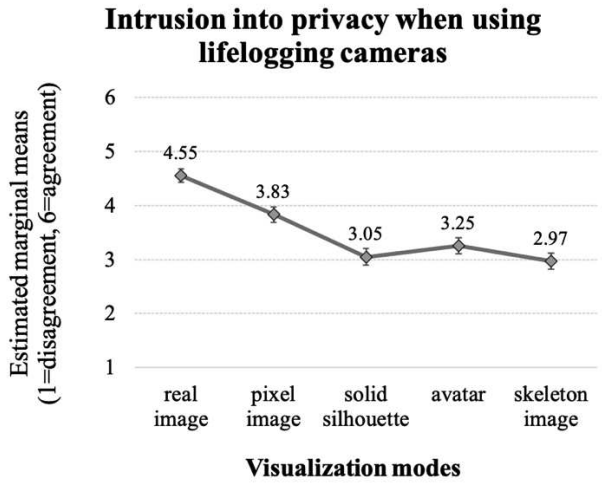


Figure 7: Main effect of the visualization modes in perceptions of intrusion into privacy when using lifelogging cameras.

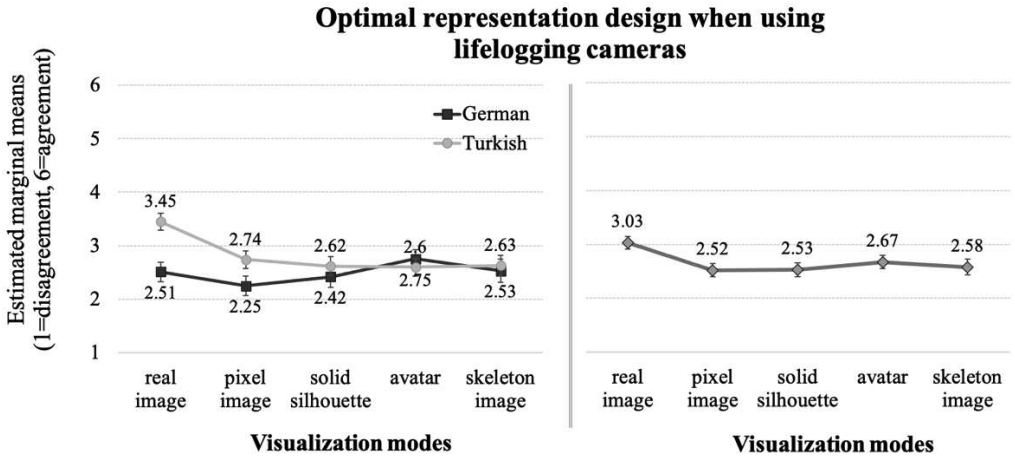
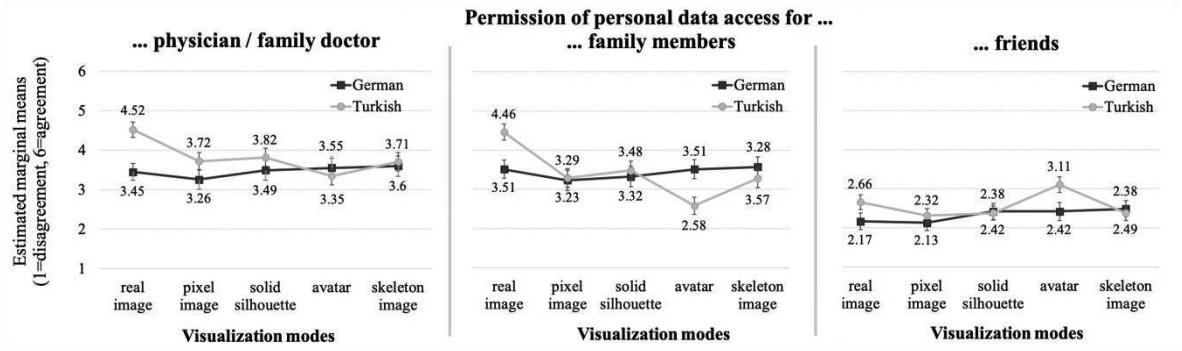


Figure 8: Main effect of the visualization modes (right) and an interaction effect of visualization and cultural background (left) on the perceptions of optimal representation design.



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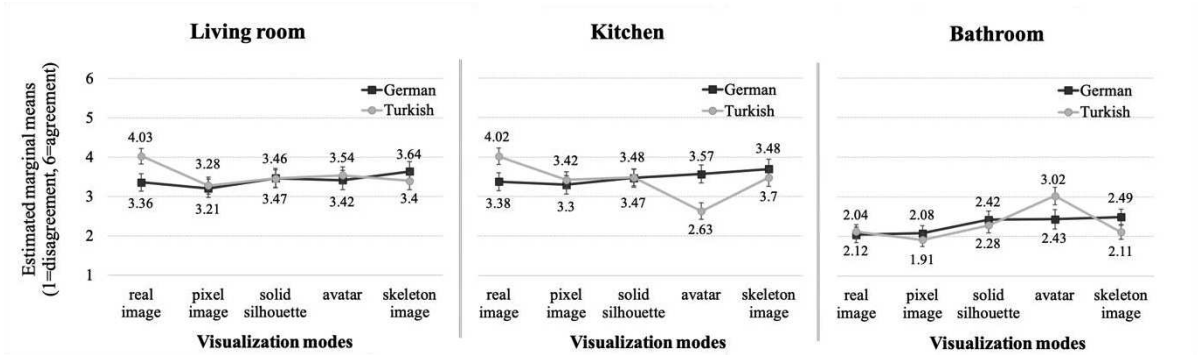

Figure 10: Interaction effects of visualization and cultural background on the accepted location of the camera use in private living spaces: living room (left), kitchen (middle) and bathroom (right).

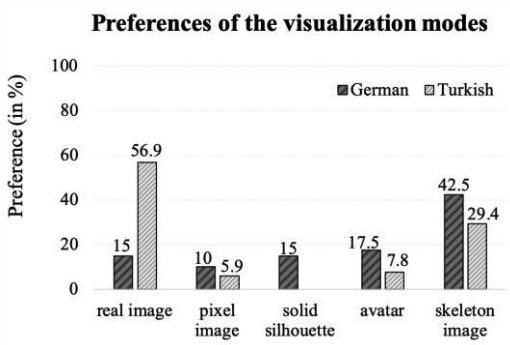

Figure 11: Ultimate preferences of the visualization modes resulting for Germans and Turks.

Table Captions

Table 1: Descriptive characteristics of the study sample (*N*=118).

Table 2: Statistical results for general perceptions of cameras as lifelogging technology in German and Turkish sample.

Table 3: Statistical results for effects of visualization modes (VM) and interaction effects of VM x cultural background (CB) on acceptance criteria for the use of cameras for lifelogging.

Table 4: Statistical results for effects of visualization modes (VM) and interaction effects of VM x cultural background (CB) on the evaluation of data access for the physician, family members, and friends.

Table 5: Statistical results for effects of visualization modes (VM) and interaction effects of VM x cultural background (CB) on the acceptance of use of lifelogging camera in the living room, kitchen, and bathroom.

Tables:

Table 1: Descriptive characteristics of the study sample (*N*=118).

Variables	Whole Sample (N=118)	German Sample (*n*=53; 45%)	Turkish Sample (*n*=65; 55%)	Difference
Age [M, (SD)]	32.2 (11.3) [min=17; max=65 years]	31.3 (11.3)	33.0 (11.3)	n.s.
Gender (female/ male)	73.7% (*n*=87) 26.3% (*n*=31)	32.1% (*n*=17) 67.9% (*n*=36)	21.5% (*n*=14) 78.5% (*n*=51)	n.s.
Education (secondary school certificate/ university qualification/ university degree)	19.6% 39.3% 41.1%	17.0% (*n*=9) 28.3% (*n*=15) 54.7% (*n*=29)	22.0% (*n*=13) 49.2% (*n*=29) 28.8% (*n*=17)	n.s.
Living Situation (alone/ with another person/ with my family)	12.7% (*n*=15) 25.4% (*n*=30) 61.9% (*n*=73)	20.8% (*n*=11) 43.4% (*n*=23) 35.8% (*n*=19)	6.2% (*n*=4) 10.8% (*n*=7) 83.1% (*n*=54)	p<.01
Living Area (urban area/ suburban area/ in the country side)	75.4% (*n*=89) 18.6% (*n*=22) 5.9% (*n*=7)	69.8% (*n*=37) 22.6% (*n*=12) 7.5% (*n*=4)	80.0% (*n*=52) 15.4% (*n*=10) 4.6% (*n*=3)	n.s.
Chronic Illness	16.9% (*n*=20)	20.8% (*n*=11)	13.8% (*n*=9)	n.s.
Health Situation ("I feel quite well."/ "I am chronically ill, but I am able to cope well in everyday life."/ "I am sometimes dependent on the help of others.")	88.1% (*n*=104) 9.3% (*n*=11) 2.5% (*n*=3)	88.7% (*n*=47) 7.5% (*n*=4) 3.8% (*n*=2)	87.7% (*n*=57) 10.8% (*n*=7) 1.5% (*n*=1)	n.s.
Professional Care Experience	15.3% (*n*=18)	17.0% (*n*=9)	13.8% (*n*=9)	n.s.
Private Care Experience "I've never cared for a sick person before."	56.8% (*n*=67)	60.4% (*n*=32)	53.8% (*n*=35)	n.s.

Table 2: Statistical results for general perceptions of cameras as lifelogging technology in German and Turkish sample.

		German participants		*Turkish participants*				
Construct	**Variables**	**M**	**SD**	**M**	**SD**	**Statistics of differences**	**Level of significance**	**Effect size**
Perceived benefits (max=78)	e.g., enhancement of autonomy, health assessment	41.4	12.0	52.3	15.1	$F(1, 117)=18.2$	$p<0.001$	$\eta^2=.13$
Perceived barriers (max=78)	e.g., invasion of privacy, feeling of surveillance, isolation	52.4	8.2	49.9	14.8	$F(1, 117)=1.2$	n.s.	--
Intention to use cameras for lifelogging (LL) (max=6)	*"I would install such a system in my house."*	2.8	1.2	3.6	1.9	Welch's $F(1,112.03)=6.73$	$p=0.011$	$\eta^2=.05$
	"I can imagine using cameras for LL."	2.7	1.3	3.6	1.8	Welch's $F(1,114.45)=8.15$	$p=0.005$	$\eta^2=.06$
	"I would like to use cameras for LL."	2.5	1.2	3.3	1.8	Welch's $F(1,110.45)=9.46$	$p=0.003$	$\eta^2=.07$
	"I'd want older family members to have such a system in their house."	3.0	1.3	4.2	1.8	Welch's $F(1,113.61)=18.09$	$p<0.001$	$\eta^2=.13$
Relevance of perceived limitations when using LL (max=6)	*"The records of the system should be accessible for a long time."*	2.4	1.6	4.0	1.9	Welch's $F(1,115.91)=25.42$	$p<0.001$	$\eta^2=.17$
	"The system does not have to have any restrictions."	2.3	1.7	3.1	1.7	$F(1,117)=5.33$	$p=0.023$	$\eta^2=.04$
	"Data protection provisions must be clearly defined."	5.7	0.8	5.1	1.6	Welch's $F(1,107.7)=10.6$	$p=0.002$	$\eta^2=.08$
	"The environment must not be recorded."	4.1	1.3	4.7	1.4	$F(1,118)=5.72$	$p=0.018$	$\eta^2=.05$

Table 3: Statistical results for effects of visualization modes (VM) and interaction effects of VM x cultural background (CB) on acceptance criteria for the use of cameras for lifelogging.

		Overall N=118	*German participants*	*Turkish participants*			
Construct	**Variables**	***M (SD)***	***M (SD)***	***M (SD)***	**Statistic of Differences** a) Main effect of VM b) Interaction effect of VMxCB	**Level of significance**	**Effect size**
Behavioral intention to use LL cameras (max =6)	*Real Image*	2.8 (1.6)	2.3 (1.2)	3.2 (1.7)	a) $F(3.13,362.71)=0.3$ b) $\mathbf{F(3.13,362.71)=4.8}$	*n.s.* $p=0.002$	-- $\eta^2=.04$
	Pixel Image	2.7 (1.4)	2.5 (1.2)	2.8 (1.6)			
	Solid Silhouette	2.6 (1.6)	2.8 (1.5)	2.4 (1.6)			
	Avatar	2.6 (1.5)	2.7 (1.5)	2.4 (1.4)			
	Skeleton Image	2.7 (1.7)	2.9 (1.6)	2.6 (1.9)			
Perception of intrusion into privacy (max=6)	*Real Image*	4.6 (1.4)	5.0 (1.0)	4.2 (1.6)	a) $\mathbf{F(3.64,422.48)=38.4}$ b) $F(3.64, 422.48)=0.6$	$p<0.001$ *n.s*	$\eta^2=.33$ --
	Pixel Image	3.8 (1.6)	4.2 (1.4)	3.6 (1.7)			
	Solid Silhouette	3.1 (1.7)	3.5 (1.6)	2.7 (1.7)			
	Avatar	3.3 (1.6)	3.5 (1.4)	3.1 (1.7)			
	Skeleton Image	3.0 (1.6)	3.3 (1.5)	2.7 (1.7)			
Perception of optimal representation design (max=6)	*Real Image*	3.0 (1.4)	2.5 (1.1)	3.5 (1.5)	a) $\mathbf{F(3.37,390.99)=3.5}$ b) $\mathbf{F(3.37,390.99)=3.9}$	$p=0.012$ $p=0.007$	$\eta^2=.03$ $\eta^2=.03$
	Pixel Image	2.5 (1.3)	2.3 (1.1)	2.7 (1.5)			
	Solid Silhouette	2.5 (1.4)	2.4 (1.2)	2.6 (1.6)			
	Avatar	2.7 (1.3)	2.8 (1.2)	2.6 (1.4)			
	Skeleton Image	2.6 (1.5)	2.5 (1.4)	2.6 (1.7)			

Table 4: Statistical results for effects of visualization modes (VM) and interaction effects of VM x cultural background (CB) on the evaluation of data access for the physician, family members, and friends.

		Overall N=118	*German participants*	*Turkish participants*			
Construct	**Variables**	***M (SD)***	***M (SD)***	***M (SD)***	**Statistic of Differences** a) Main effect of VM b) Interaction effect of VMxCB	**Level of significance**	**Effect size**
Permission of data access for physician/ family doctor (max =6)	*Real Image*	4.0 (1.6)	3.4 (1.5)	4.5 (1.6)	a) ***F*(3.46,400.99)=4.24** b) ***F*(3.46,400.99)=5.27**	p=0.004 $p \leq 0.001$	η^2=.04 η^2=.04
	Pixel Image	3.5 (1.8)	3.3 (1.6)	3.7 (1.9)			
	Solid Silhouette	3.7 (1.8)	3.5 (1.7)	3.8 (1.9)			
	Avatar	3.4 (1.8)	3.6 (1.6)	3.3 (2.0)			
	Skeleton Image	3.7 (1.8)	3.6 (1.6)	3.7 (2.0)			
Permission of data access for family members (max=6)	*Real Image*	4.0 (1.7)	3.5 (1.6)	4.5 (1.7)	a) ***F*(3.55,412.02)=9.72** b) ***F*(3.55,412.02)=9.38**	p=0.001 p=0.001	η^2=.08 η^2=.08
	Pixel Image	3.3 (1.9)	3.2 (1.7)	3.3 (2.0)			
	Solid Silhouette	3.4 (1.9)	3.3 (1.7)	3.5 (2.1)			
	Avatar	3.0 (1.8)	3.5 (1.8)	2.6 (1.7)			
	Skeleton Image	3.4 (1.9)	3.6 (1.8)	3.3 (2.0)			
Permission of data access for friends (max=6)	*Real Image*	2.4 (1.6)	2.2 (1.3)	2.7 (1.7)	a) ***F*(2.75,319.41)=4.53** b) ***F*(2.75,319.41)=3.49**	p=0.005 p=0.019	η^2=.04 η^2=.03
	Pixel Image	2.2 (1.4)	2.1 (1.2)	2.3 (1.6)			
	Solid Silhouette	2.4 (1.5)	2.4 (1.3)	2.4 (1.6)			
	Avatar	2.8 (1.7)	2.4 (1.4)	3.1 (1.8)			
	Skeleton Image	2.4 (1.5)	2.5 (1.5)	2.4 (1.5)			

Table 5: Statistical results for effects of visualization modes (VM) and interaction effects of VM x cultural background (CB) on the acceptance of use of lifelogging camera in the living room, kitchen, and bathroom.

		Overall N=118	*German participants*	*Turkish participants*			
Construct	**Variables**	***M (SD)***	***M (SD)***	***M (SD)***	**Statistic of Differences** a) Main effect of VM b) Interaction effect of VMxCB	**Level of significance**	**Effect size**
Acceptance of camera use in living room (max =6)	*Real Image*	3.7 (1.6)	3.4 (1.6)	4.0 (1.6)	a) ***F*(3.61,419.22)=2.60** b) ***F*(3.61,419.22)=2.80**	p=0.043 p=0.031	η^2=.02 η^2=.02
	Pixel Image	3.2 (1.7)	3.2 (1.5)	3.3 (1.9)			
	Solid Silhouette	3.5 (1.8)	3.5 (1.6)	3.5 (1.9)			
	Avatar	3.5 (1.8)	3.4 (1.6)	3.5 (1.9)			
	Skeleton Image	3.5 (1.8)	3.6 (1.6)	3.4 (2.0)			
Acceptance of camera use in the kitchen (max=6)	*Real Image*	3.7 (1.7)	3.4 (1.6)	4.0 (1.7)	a) ***F*(3.48,404.11)=4.87** b) ***F*(3.48,404.11)=7.54**	p=0.001 p<0.001	η^2=.04 η^2=.06
	Pixel Image	3.4 (1.7)	3.3 (1.5)	3.4 (1.8)			
	Solid Silhouette	3.5 (1.7)	3.5 (1.6)	3.5 (1.7)			
	Avatar	3.0 (1.7)	3.6 (1.7)	2.6 (1.7)			
	Skeleton Image	3.6 (1.8)	3.7 (1.6)	3.5 (1.9)			
Acceptance of camera use in bathroom (max=6)	*Real Image*	2.1 (1.4)	2.0 (1.3)	2.1 (1.5)	a) ***F*(3.39,392.91)=7.93** b) ***F*(3.39,392.91)=3.29**	p<0.001 p=0.017	η^2=.07 η^2=.03
	Pixel Image	2.0 (1.4)	2.1 (1.4)	1.9 (1.3)			
	Solid Silhouette	2.3 (1.5)	2.4 (1.4)	2.3 (1.6)			
	Avatar	2.8 (1.8)	2.4 (1.4)	3.0 (2.0)			
	Skeleton Image	2.3 (1.5)	2.5 (1.4)	2.1 (1.5)			

Short Biographies of the Authors:

Dr. phil. Wiktoria Wilkowska:

Wiktoria Wilkowska is psychologist working as a senior researcher at the Human-Computer Interaction Center and lecturer at the Department of Communication Science at RWTH Aachen University in Germany. Her research focuses on human factors in the exploration of technology acceptance in the field of medical assistance systems in home environments.

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Julia Offermann-van Heek is working as a research assistant and PhD student at the Human-Computer Interaction Center at RWTH Aachen University in Germany. She holds a master's degree in communication science combined with basics of mechanical engineering. Her PhD research focuses on the acceptance and perception of assisting technology.

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Francisco Florez-Revuelta is an Associate Professor at the Department of Computing Technology, University of Alicante, Spain. His research is focused on privacy-aware and acceptable technologies and services to support an active and healthy aging of older and/or disabled people, particularly those technologies using video-based sensors.

Prof. Dr. Martina Ziefle:

Martina Ziefle is professor for Communication Science, head of the Chair for Communication Science and founding member of the Human-Computer Interaction Center at RWTH Aachen University in Germany. Her research focuses on the interface between humans and technology, taking into account different usage contexts and user requirements.

Table of Responses to IJCHI Reviewers' Comments

Reviewer #	Reviewer Issue/Comment to Be Addressed	Response/Action Taken	Document Location
2	„The results provide interesting findings on the differences between German and Turkish. Overall, this paper is well written. The logic flow is clear and the results were well supported by data. Minor suggestions to further refine this paper are listed below: "	Thank you very much for your review and your suggestions. We included different modifications as accordingly reported below. We have incorporated the particular modifications into our manuscript accordingly.	---
2	"First, it is necessary to indicate the sampling procedure. Understanding how to reach participants from two countries would help readers interpret the results."	Thank you for your comment. You are right that information about the sampling is important for the understanding of the procedure. Therefore, we mentioned already in the submitted version of the paper that the German questionnaire was translated into Turkish and this version of the survey was additionally disseminated in Turkey via social media and through private contacts of the authors. Hence, both questionnaires, in German and in Turkish, were disseminated through private contacts of the authors and social media and reached German as well as Turkish participants (living in Germany or in Turkey). We have specified our explanation of the sampling in Germany and Turkey.	Method: Online Survey
2	"Second, the theoretical contribution of study may be further stressed. The literature section provides many closely related studies, most of which were not included in the discussion section, so the authors may want to further discuss findings in comparison to them."	Thank you for the great suggestion: We have now included the results of the previous related studies, as introduced in the theoretical background of the manuscript, and discussed their outcomes in comparison to our present study.	Discussion
2	"Finally, it would be good to present error bars in the figures and the scenario used in this study."	Absolutely correct. We apologize for this omission. We complemented all relevant figures with the particular error bars, making our results more transparent.	Results
3	"The manuscript is well-written and touches a sensitive issue being privacy and acceptance of video-based lifelogging technologies. However, a few modifications can make this paper better."	Thank you very much for your review and this comment. We included different modifications as accordingly reported below.	---
3	"First of all, in page 11 the authors pose the main research questions formulated for this research are presented, but they are forgotten in the rest of the text. My recommendation would be to specifically mention them in the results and discussion sections and highlight the answers emerged."	Thank you very much for this recommendation. We added specific hints to the research questions within both the "Results" and the "Discussion" sections, so that it is better recognizable to which research question the respective section/paragraph refers. We also further specified the answers to the questions.	Results & Discussion
3	"Secondly I personally find the charts used in images 4 and 5 somehow difficult to read. The authors should consider using alternative charts or displaying the exact numbers each bar represents on the charts (for all images, not just 4 and 5) so that the readers can have a clearer perception on the data presented."	Thanks for this valuable comment! As suggested, we added in all charts of the manuscript the exact values in order to better present the results to the reader. We also added the standard error bars for each resulting value to make the results more comprehensible for the readership.	Results
3	"Another comment is to clarify how the two focus groups affected the research - did they were used to form the questions for the online survey? Were they were used to explain the online survey results? Other?"	Thank you very much for your questions with regard to the conducted focus groups. In fact, the focus groups were predominantly conducted in order to identify relevant criteria for the perception and acceptance of video-based lifelogging technologies. Building on that base, the qualitative results of the focus groups were used to form the questions/items of the online survey. Considering the results of the online survey—that provides insights in absolute evaluations and weightings—the results of the focus groups in turn have the potential to explain the reasons of some evaluations. Hence, you are finally right that we used the results of the focus groups in these both ways. Therefore, we added a more detailed explanation of our procedure within the section "Research Design".	Research Design

3	„Finally, the authors may conclude to some suggestions (if there can be any) for future researches to take into account when designing video-based lifelogging systems.”	Thank you for this suggestion. Of course, our results do not enable us to derive holistic design guidelines for lifelogging technologies. However, we are able to derive recommendations based on our findings (e.g., with regard to the handling of data and privacy). Therefore, we added a specific paragraph with such recommendations on the end of the “Discussion” section.	Discussion
Editor	Please also confirm that your paper conforms to the APA style guidelines.	We reviewed more precisely the whole manuscript, but especially the literature references and adapted these to the APA guidelines.	Whole manuscript, References