Older women's perceptions of a programmable video monitoring system at home: A pilot study

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Introduction Developing technologies to help older adults to age in place is paramount in coping with health challenges related to the ageing population. Camera-based technologies are efficient for home monitoring; however, few studies exist of users' perceptions of these technologies. To monitor night walks and the person-environment interaction, a programmable video monitoring system (VS) was implemented at home. This study explores users' perceptions of this VS. **Methods** For this multiple case study, six older women were recruited according to these criteria: (1) ≥65 years old; (2) ≥ one fall within the last 12 months; (3) woke up at night to go to the toilet; (4) lived alone. The VS was implemented for seven nights. Perceptions were explored with semi-structured interviews before and after the experiment. Data were analysed qualitatively following a cross-case method. **Results** Participants had positive opinions of the VS before the implementation; they appreciated three features: (1) the programmable movement detection during chosen time slots, respecting privacy; (2) the LED indicating the recording; (3) the small cameras. After the experiment, participants reported positive experiences, though some expressed some discomfort. During the experiment, participants' perceptions changed because they got used to the system. **Conclusion** Older women's favourable opinion of programmable VS supports the use of ambient technologies to facilitate ageing in place. Future research should involve larger samples to confirm the possibility of using programmable VS with community-dwelling older adults.

Keywords: older adults, ageing in place, technology, video monitoring, falls

Introduction

The world's population is ageing: in 2050, older adults will represent 30 per cent of the population in Canada, Western Europe, China and Chile (World Health Organization, 2015). Ageing leads to an increased risk of disabilities and falling: 30 per cent of older adults fall each year; after age 85, the proportion rises to 50 per cent;

and among older adults suffering from incontinence, 35 per cent fall each year (Foley et al., 2012; World Health Organization, 2008, 2015). Older women are more at risk of falling: 20% of them fall at home, and women with urinary incontinence are significantly more at risk of falling than others; 40% of women with urinary incontinence fall within a given year (Foley et al., 2012). Despite these risks, older adults prefer to age at home (Cheek, Nikpour, & Nowlin, 2005; World Health Organization, 2015). However, age-related multi-comorbidity increases health care needs such that health systems alone cannot address them (Boissonneault, Légaré, & Décarie, 2014). Informal caregivers (unpaid, non-professional caregivers) compensate for these deficiencies: for example, in the United States of America, between 1999 and 2015, caregivers provided 30 hours of care per week (Wolff et al., 2017; World Health Organization, 2015). Given the ageing population, there are no longer enough caregivers and the demand for health care will double by 2050 (OECD, 2013). Thus, developing new health care perspectives is crucial.

According to the World Health Organization (WHO), new technologies, especially monitoring technologies, can help older adults to age in place and improve their quality of life (Mahmood, Yamamoto, Lee, & Steggell, 2008; Van Hoof, Kort, Rutten, & Duijnstee, 2011; Wiles, Leibing, Guberman, Reeve, & Allen, 2012; World Health Organization, 2015). Gerontechnologies are defined as "technology and environment for independent living and social participation of older persons in good health, comfort, and safety" ('International Society for Gerontechnology', n.d.). The WHO recommends exploring users' needs and preferences for gerontechnologies (World Health Organization, 2015). Some reviews highlight the lack of studies on the use and efficiency of gerontechnologies with community-dwelling older adults (Lapierre et al., 2018; Piau, Campo, Rumeau, Vellas, & Nourhashemi, 2014). Moreover, in their review regarding technology acceptance by older adults, Peek et al. (2014) mentioned that most studies explored users' acceptance without having them use the technology. In their literature review, Pietrzak, Cotea, & Pullman (2014) showed that, although privacy and intrusiveness were among users' main concerns, their health needs were more important in positively affecting their perception of the technology. For example, some studies exploring the implementation of a monitoring technology involving trackers or sensors showed that these technologies are acceptable if they do not interfere with older adults' daily life (Chen, Harniss, Patel, & Johnson, 2014; Reeder et al., 2013).
Among existing monitoring technologies, camera-based technologies are efficient at detecting and monitoring activities in laboratories, but few studies have evaluated them at home with community-dwelling older adults at risk of falling, and fewer still have explored participants' opinions (Chaudhuri, Thompson, & Demiris, 2014; Lapierre et al., 2018). When users' perceptions of video monitoring technologies are explored after use, the technologies often involve continuous recording of images (Vincent, Reinharz, Deaudelin, Garceau, & Talbot, 2006), which raises ethical concerns. Developing intelligent or programmable systems that do not continuously record personal data seems to be a promising avenue to address these concerns (Comité national d'éthique sur le vieillissement, 2015; World Health Organization, 2015). Exploring users' perceptions of a programmable video monitoring system (VS) for fall prevention, based on a person-environment (P-E) interaction analysis, would therefore address a gap in the scientific literature and act on the WHO's recommendation (World Health Organization, 2015).

The Model of Competence (Rousseau, Potvin, Dutil, & Falta, 2002), the conceptual framework underlying this study, defines P-E interactions by means of six concepts: (1) Person; (2) Environment (human and non-human); These concepts interact through (3) roles and (4) activities, representing the P-E interactions leading to (5) a competency situation or (6) a handicap situation. The operationalisation of the model is presented in *Figure 1*.

The Model of Competence enables one to consider participants' needs and preferences as well as the environmental requirements regarding the programmable VS and its impact on P-E interactions at home. This study is part of a pilot project exploring the walking and balance characteristics of older women at risk of falls when experiencing urinary urgency. The study involves two contexts: the laboratory and home. This article focuses on the implementation of a programmable VS to observe participants' walking and balance at home when experiencing urinary urgency; thus, the VS monitored their night walks on the way to the toilet. The aim of this pilot study is to explore the perception of older women at risk of falls regarding the use of a programmable VS at home.

Methods

Based on the P-E conceptual framework, the perceptions of six participants recruited from the group of laboratory participants were explored regarding the use of a programmable VS recording them at home when they experienced urinary urgency (on their way to the toilet) at night.

Design

A multiple case study design (Yin, 2014) was used to answer the research question "How do older wom-

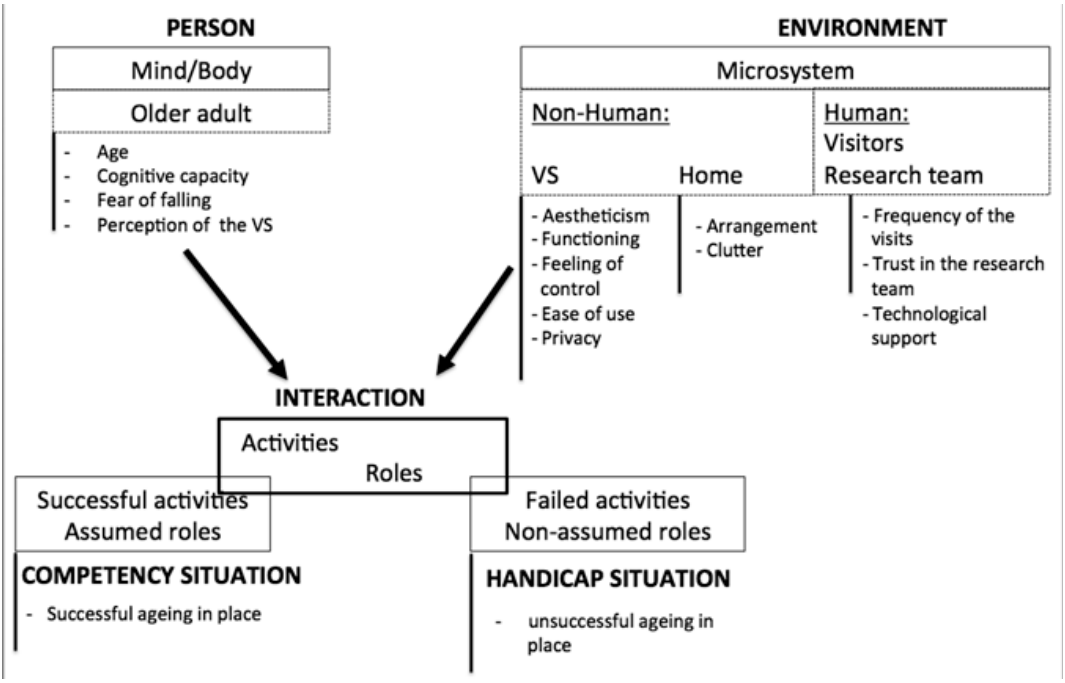

Figure 1. Operationalisation of the Model of Competence (Rousseau et al., 2002): (1) the person, here, is the older adult, (2) the nonhuman environment, is the home and the video monitoring system, the human environment includes visitors and the research team. (3) Roles are not relevant here. (4) The activity is walking to the bathroom. Person-environment interactions lead to (5) a competency situation, (ageing in place: the older adult can move around safely at home) or (6) a handicap situation (falls hinder ageing in place).

en at risk of falling perceive the use of a programmable VS at home?". The project was approved by the ethics committee of Montreal Geriatric University Institute (IUGM) (CER IUGM 14-15-025).

Participants

Participants were recruited in Montreal, between June 2015 and July 2016, according to the following selection criteria: (1) ≥ 65 years old; (2) ≥ one fall per year; (3) Woke up at night to go to the toilet; (4) Lived alone; (5) Had a standard ceiling height (≈243 cm); (6) Were either continent (no urine leakage during the past year) or incontinent (score ≥ 6 on the short form of the International Consultation on Incontinence Questionnaire and at least three urine leakages per week) (Avery et al., 2004). Women with diagnosed psychiatric disorders or using walking aids were excluded.

Procedure

Participants were recruited from the Research Center of the Montreal Geriatric University Institute participants database participant database. Six participants from the laboratory phase (n=3 continent, n=3 incontinent) were asked to participate in the phase at home, consisting of the installation of the programmable VS for seven nights. On day 0 (first visit), the first author collected each participant's informed consent and information about her home (see details under Data collection) and living habits. On day 1 (implementation day), three or four cameras were installed (≈1/room depending on environmental characteristics) in the bedroom, hallway, and bathroom for seven consecutive nights and the recording periods were programmed (time slot chosen by each participant). On day 2 and day 5, the first author visited each participant to check the system (setting and recording on SD cards). In accordance with the recommendations of the National Ethics Committee on Aging, recorded images were shown to the participant (Comité national d'éthique sur le vieillissement, 2015). Participants received a daily call to check on their well-being and on the VS. Participants could verify if the VS was recording: the cameras had a LED that flashed when they were recording.

Data collection

During the laboratory phase, participants completed the simplified ABC scale (Filiatrault et al., 2007) and the Montreal Cognitive Assessment (MoCA) (Nasreddine et al., 2005) to describe their cognitive status and their confidence in their balance when performing everyday life activities.

At the first meeting (day 0), participants' functioning, habits, and perceptions of the programmable

Figure 2. Example of the VS in a participant's home

VS were collected by the first author during a semi-structured interview (mean duration: 45 minutes). The questionnaire included 11 closed-ended questions (yes/no) with an option to explain the answers and 14 open-ended questions. Time slots chosen by participants for night recording were noted; no minimum duration was imposed. Characteristics of the environment (e.g., architecture, furniture) were recorded (photographs, sketches and observation grids). A multidisciplinary team (expertise in computerised image processing, gerontology and rehabilitation) planned the VS setting. Throughout the implementation, the first author completed a daily log to document events likely to influence the results. On day 8, the VS was removed and another semi-structured interview (mean duration: 55 minutes), similar to the first one, was done. This study focuses on the data from the semi-structured interviews.

Material and equipment

The programmable VS consisted in high-definition cameras (ZIR32 by Zetta©). Each camera was equipped with a 32-GB micro SD card to store the videos. The cameras allowed wide angles and night recording (infrared lens). They were programmed to record when triggered by movement detection for a night-time slot chosen by the participant. Each camera was attached to either a flexible, magnetisable tripod or a short rigid tripod, depending on the environment (*Figure 2*).

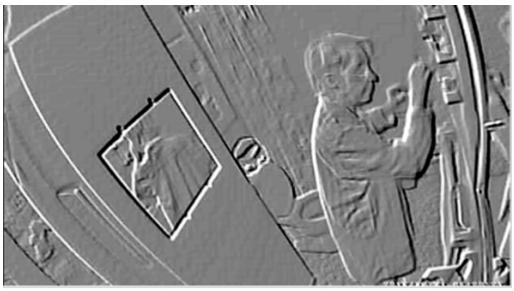

Figure 3. Example of image processing with the AVS Video Converter© software

Video images were processed (blurred) on a computer using AVS Video Converter software© (Online Media Technologies Ltd., n.d.) to respect participants' privacy (*Figure 3*).

Data analysis

Based on Yin's "Relying on theoretical propositions" strategy (Yin, 2014, p. 136), analyses were performed using QDA Miner software (Provalis Research, 2016). A code list was based on the interview questionnaires and the conceptual framework (55 codes); two codes were added to handle new elements raised by participants. To validate the coding, two co-authors independently coded part of the interviews and then compared their coding. Two steps were needed; a 63 per cent inter-rater agreement was reached. Each discrepancy was discussed to reach agreement. The principal researcher validated each data reduction step. Sociodemographic data and results on the ABC scale and the MoCA were analysed descriptively to provide information on participants' profiles. The answers to the closed-ended questions from the main questionnaire were analysed descriptively to complete the qualitative data. Based on Yin's cross-sectional synthesis, each case was first treated as a separate data set, then the entire data set was analysed qualitatively to reach a cross-case conclusion (Yin, 2014, p. 165).

Results

All the women contacted agreed to participate and none withdrew during the project. Their profiles are displayed in *Table 1*.

VS aesthetics

Before the experiment, all participants appreciated the look and small size of the VS. One participant said: "*I think it's pretty. That's good; it's very small and practical. And the tripod, I think it's amusing. It's very discreet; the tripod attracts more attention actually. It's like E.T.*" (F041). One participant did not care how the VS looked. Another pointed out a feature she liked less: "*The only snag would be the light [LED on cameras], but I'll sleep well with that*" (F032).

After the experiment, their opinions did not change. Two participants said it had no importance for them. The others enjoyed it; one explained: "*Very pretty [cameras]! I think they're fun, (…) they're like characters*" (F054).

Table 1. Participant profiles

Participant codes and mean	Age	Civil status	Type of home	Highest educational level completed	Number of falls/year	Number of bathroom trips/night	ABC score (%)[a]	MoCA score/30[b]
Mean (standard deviation)	73.7 (4.5)	-	-	-	1.6 (0.5)	2.2 (0.8)	74.2 (18.2)	27 (2.4)
F001	68	Divorced	Two-level apartment	College degree	2	2	73.3	26
F032	76	Widowed	Apartment	University degree	2	1	71.1	25
F041	75	Single	Apartment	University degree	2	3	80.0	30
F054	80	Divorced	Apartment	University degree	1	2	97.8	25
F148	69	Single	Apartment	University degree	2	2	80.0	30
F175	74	Widowed	Bungalow	High school	1	3	42.2	26

[a] A score of 0 per cent means not confident about keeping balance while doing activities; a score of 100 per cent means very confident about keeping balance (Filiatrault et al., 2007).
[b] A score ≥26 indicates a normal cognitive state (Nasreddine et al., 2005).

VS operation

Most participants understood the recording based on movement detection in a chosen time slot. They all had a favourable opinion of this functioning: "*It's a good technology. It's a bit like my motion detectors; they do one thing*" (F001). Specifically concerning the recording on movement detection, some participants saw an advantage for the research team:

"*I think it's perfect, it would be a lot of time for you to watch nothing [while participants are asleep], you'd look at it while thinking 'maybe she'll get up sometime'. As for us, we're lying down, we don't mind.* " (F041)

Participants mentioned that recording in a time slot preserved their privacy. One participant said: "*It's good that it stops at some point. I'm not sure I would have participated otherwise; I would have been very hesitant*" (F175).

At the end of the experiment, participants still had a positive opinion of the system's operation. Recording in one time slot reassured them. One said: "*I didn't have to worry about the cameras. In my mind, I trusted them not to work [during the day]*" (F001). The recording on movement detection was a positive element; one participant said: "*It [recording on movement detection] was good; I felt less spied on*" (F054). Furthermore, the LED flashing when recording reassured participants that the system was operating properly. Participants appreciated customising the cameras' location; one said: "*It's not intrusive at all. I could open cupboards easily. I didn't run into it. In the bedroom, it was in the corner*" (F041). Regarding the customised time slot, one participant explained:

"*What had reassured me was that we had set hours [time slot]. Of course I wouldn't have undressed during the day; that's why I chose midnight to 5:00, because I was in bed at those times. (...) it doesn't affect my privacy.*" (F001)

Conversely, one participant mentioned that the customisation of the VS was not important to her because she was out during the day. Instead, she appreciated the customisation of the implementation procedure and explained:

"*I chose the days and scheduling of the calls; you adapted to my schedule. (...) I didn't have to worry about wanting to leave and she [the first author] didn't call. (…) I didn't have any trouble with that.*" (F148)

Video storage

Video images were stored in each camera's SD card; participants preferred this rather than storage in the Cloud. One explained: "*I feel more secure with that. With that [the SD card], it would surprise me if it's found on the Internet*" (F001). One participant had difficulties understanding how the Cloud works and preferred storage in SD cards because it appeared easier. Two participants had no preference; one explained: "*It doesn't bother me. Anyway, who would be interested?*" (F032). She specified that her opinion was based on the recorded activity: "*It depends on what you record. But for this, it wouldn't have bothered me*" (F032). Another considered both storage types risky: "*One technology or another, they're safe, but there can always be breakdowns*" (F041).

On day 8, they still preferred storage in SD cards rather than in the Cloud. One participant explained: "*I like it better this way; it seems to me that it stays here (…) I wouldn't have felt secure… I don't know if I would have participated; I probably would have thought about it more*" (F175). The others said it was not important to them.

Ease and concerns

Overall, before the experiment, participants reported no apprehension about being videotaped.

Table 2. Changes in participants' behaviour

Participant code	Opinion
F032	"[laughter] I tried not to move [in bed] and it absolutely didn't work."
F041	"I wouldn't have walked around naked even if it's hot."
F041	"I haven't changed my routine, but I was aware of the cameras."
F054	"In the bedroom only, the others [cameras] didn't bother me at all. I experienced this as an intrusion. That changed my behaviour, as I told you earlier. Not my behaviour… my habits. Small habits. (…) Like I said the other day, when I wake up, I read and I refrained from reading, except for tonight."
F175	"I didn't say to myself 'I should not get up because I am going to be filmed'. No, I got up anyway."

One explained: "*It won't affect my privacy, it will only be the time you need*" (F001). Another said that her perception depended on the image processing of the video: "*if you tell me that (…) nobody would recognise me, I trust you*" (F175). However, some raised concerns such as dropping the camera or being filmed in the shower. Two participants felt uncomfortable receiving visitors during the experiment; one explained: "*I don't entertain much, so I won't need to answer lots of questions*." (F148)

After the experiment, some participants mentioned forgetting the cameras for days. One said: "*I don't know why, for days, I didn't feel like I was being watched*" (F175). Another went further, saying: "*I acted as if they weren't there. I really felt that they weren't there*" (F001). However, some concerns mentioned on day 0 were confirmed on day 8: the fear of explaining the VS to visitors persisted. One participant explained: "*I haven't told anyone about my incontinence problem so… I remained a little embarrassed (…).*" (F148). However, two participants did not feel uncomfortable. One said: "*Well, I lived with it, I was comfortable, I had no problem*" (F148). The automatic image processing was key for some participants. One said: "*I think it's essential; I like it better (…) because it's not… we're not making movies here*" (F054). For others, this feature was not a condition of their participation: "*It's not like you were looking at a photograph. In addition, from what I saw, it's blurred, you can't recognise the person (…). The image's already blurred; blurring it more doesn't change much, I don't know. I don't know because, even if someone looks, watching someone on the toilet isn't very interesting.*" (F041)

Participants could see examples of the recorded images on day 2 and day 5 and noticed that images were already blurred because of the infrared vision; it reassured them that their privacy was respected.

Influence on behaviour

Some participants changed their behaviour during the experiment. One participant said that she did not shower in her bathroom for fear of being filmed while naked or damaging the VS by splashing it (see other examples in *Table 2*). However, two other participants said they had not changed their habits during the experiment.

Overall perception

On day 0, participants had positive opinions regarding the VS implementation. They mentioned feeling comfortable and safe: "*Maybe because I'm used to my motion detector [alarm system], I'm used to having a camera that monitors my*

Table 3. Changes in participants' perceptions of the VS

Participant code	Day 0	Day 8
F001	"It does not bother me."	"It didn't bother me."
F032	"I have no concerns."	"It really didn't bother me."
F041	"I don't want to stumble over it."	"Now that I know how it works, it's not so intrusive. Initially, it seems quite intrusive, but it isn't so much."
F054	"I don't think it will bother me much." "It's true that it is rather an invasion of privacy."	"I was really aware of the cameras; there was some discomfort there, yes."
F148	"I feel comfortable, but I will keep an eye open."	"I lived with it and I was comfortable. I had no problems."
F175	"It's a little embarrassing but I trust you."	"Sure, the first day it was more embarrassing. Afterwards, you get used to it when you see that it doesn't record all the time."

movements" (F001). However, one participant qualified this opinion saying: "*I… feel comfortable, but I will keep an eye open, I will pay attention to what is happening*" (F148).

At the end of the experiment (day 8), participants reported a positive experience. One said: "*I liked my experience. I don't regret it. I would do it again*" (F001). As shown in *Table 3*, three participants' opinions did not change during the experiment, whereas three others did change their opinions. Despite a rather positive opinion before the implementation, one participant found it difficult to accept the camera in her bedroom. During the three first daily calls, she reported problems falling asleep and felt she was being watched. She was given a chance to withdraw from the project but insisted on continuing. After the experiment, she explained:

"*I have to admit that the camera bothered me. That's the difference. I was really aware of the cameras and maybe I woke up more often, I'm not sure: it depends on the night. (…) The cameras influenced me. The flashing bothered me. I knew that when I moved, it lit up. I tried not to see it, to cover my eyes so I couldn't see the flashing.*" (F054)

She also said: "*I think I had more [concerns] than I thought; especially in my bedroom; it changed my night habits*" (F054). However, two other participants' perceptions became more positive. One of them explained:

"*At the beginning, I checked to see if the cameras were working. I was aware that there were cameras, but it didn't bother me. When I saw on Monday that they were working well, I was keeping an eye on it but I didn't care anymore.*" (F041)

Some participants mentioned getting used to the VS during the experiment. One said: "*It was more intimidating the first day, but then it subsides. Because we're not used to this, it's an unknown thing*" (F175). Another said: "*For sure, at first we forget less often, but then, with time, we don't even think about it*" (F032)

Discussion

This multiple case study enabled us to explore six older women's perceptions of the use of a programmable VS at home for seven nights.

Perceptions before implementation

Despite the common belief that people would refuse to be filmed, every woman contacted agreed to participate. One participant (the oldest one) needed more explanations of how the system worked but had a good opinion of the VS. This is consistent with Mahmood et al.'s (2008) study showing that age does not hinder the use of technologies. The participants' positive perception is consistent with studies exploring older adults' opinions regarding VS (Londei et al., 2009; Vincent et al., 2006). This implies that the programmable VS represents a promising way to apply the WHO's recommendation that remote monitoring systems be developed for community-dwelling seniors. Acceptance of the VS was probably influenced by the participants' fall risk. As mentioned in previous studies, older adults are willing to accept technology if it addresses a health issue or improves their safety (Londei et al., 2009; Pietrzak et al., 2014). This suggests that the technology is considered acceptable if it leads to a competency situation (referring to our conceptual framework) for the person (Rousseau, 2017; Rousseau et al., 2002).

Furthermore, one participant feared stumbling over the VS before the installation of the system; its setup was planned to minimise the probability of tripping, which reassured participants and did not create a handicap situation according to the conceptual framework of the study (Rousseau, 2017; Rousseau et al., 2002). To foster a positive perception, the system's implementation should facilitate its embedding into the environment; the system's aesthetics should blend into the home environment and the VS should be thought of as an integrated system in the home (Lapierre et al., 2015; Rousseau, 2017; Rousseau et al., 2002).

Finally, explaining the presence of cameras to visitors was a common concern because participants did not want to share their medical status. In their study, Reeder et al. (2013) mention that some visitors did ask questions about the sensors they were testing at home. Thus, the small size of the VS and its appearance did not make it less stigmatising. On this issue, one participant suggested using white cameras to blend with the walls more easily and look trendier, which is an element that should be considered in technological design.

Perceptions after implementation

After the experiment, perceptions of the system were still positive. This finding is consistent with the literature and matched participants' pre-experiment perceptions (Vincent et al., 2006). It suggests that exploring potential users' perceptions before implementation may accurately predict their actual acceptance, in accordance with the Technology Acceptance Model (TAM): "*behavioural intention to use" is related to "actual use*" (Davis, 1985). Participants' positive opinions after the experiment also imply that implementing a VS to monitor night walks should be considered in a remote care context as it addressed the older adults' internal expectations of the VS (e.g., respect of their privacy) (Rousseau et al., 2002). One participant expressed a negative perception of the system after the experiment. The difficul-

ties she had understanding how the VS worked (i.e., recording in a time slot) may have influenced her opinion. The person's understanding is an essential element to consider in technology acceptance models and for future implementation.

The ease of use of the system (participants did not need to activate or deactivate the system), the automatic image processing (blurred images) and the programming helped us manage the implementation: more specifically, challenges related to privacy, usability and acceptance. Indeed, the ease of use, as defined in the Technology Acceptance Model (Chen et al., 2014; Davis, 1985), was identified as an important factor influencing positively participants' perception. Developing an implementation procedure (e.g., time slot chosen according to participants' schedules, daily calls) that respects older adults' routines and provides support is also an element that favours acceptance and should be considered for future technology implementations at home. Blurring the images and programming time slots were key factors in preserving participants' privacy. This differs from a previous study showing that clear images were preferred for intelligent VS for fall detection (Londei et al., 2009). This discrepancy may be related to the technology's purpose: clear images are preferred in emergencies; blurred images, for monitoring (Londei et al., 2009). Thus, future technology development should consider the aim of the camera-based technology when looking for a way to preserve users' privacy. In our study, privacy concerns were an issue for only one participant, but she decided to ignore them, which is consistent with the studies of Peek et al.' (2014) and Pietrzak et al. (2014) showing that privacy is less important for users than their health needs and safety.

Changes in perception

Comparing the before and after interviews enabled us to explore the changes in participants' perception, which evolved throughout the project and remained generally positive at the end. Most participants mentioned getting used to the VS while it was there. Chen et al. (2014) found that their monitoring system was accepted for three to six weeks. Furthermore, one participant in our study mentioned that she would do the experiment again. This suggests that longer periods are acceptable. Thus, future research should focus on longer implementation time to explore the effects of time on users' perceptions.

Theoretical model

This study highlights variables influencing older women's perceptions of technology implementation. Recording on motion detection in a chosen time slot makes the technology easier to use and facilitates the interaction between older adults and their non-human environment (VS) (Person-technology interaction) (Rousseau, 2017; Rousseau et al., 2002). Ease of use is mentioned in the TAM (Davis, 1985). Furthermore, the daily calls enabled participants to ask questions and share their concerns. They reassured them and eased their interactions with the VS. Mahmood et al. (Mahmood et al., 2008) identified support as a facilitator. However, other variables influencing our participants' perceptions are not integrated into current technology acceptance models; for example, respect of privacy and habits, the feeling of control over the technology provided by the choice of time slot, the possibility of checking whether or not the system is recording (with the LED) and the fall risk (the handicap situation), all influence the technology acceptance and the way the technology addresses the internal expectations of the older adults (Rousseau, 2017; Rousseau et al., 2002). Integrating these elements into existing models would ease the development of gerontechnologies adapted to older adults' needs. The Model of Competence allows these concepts to be operationalised, as presented in *Figure 1*.

Strengths and limitations

One strength of this study is the data triangulation (Creswell, 2013): semi-structured interviews pre- and post-experiment enabled us to explore changes in participants' perceptions. The daily calls and daily log complemented data from the semi-structured interviews and documented their context as recommended by Creswell and Yin (Creswell, 2013; Yin, 2014). The participants' heterogeneity is another strength: age range (68–80), education level (high school diploma to university degree), physical and cognitive health (continence, incontinence, MoCA results) and ABC results. This is congruent with Yin's recommendations for multiple case studies (Yin, 2014).

However, the study has limitations: it is part of a project focusing on women. Thus, men's perceptions remain to be explored. Participants were recruited through a participant database; therefore, they may already have had positive perceptions of innovations. Moreover, for the laboratory part, participants needed to be able to walk without aids; thus, our sample contained only women at a low risk of falling (mean 1.6 falls/year) and with good mental health, which may have influenced the results. Future research should include participants with various profiles.

Conclusion

This study enabled us to explore the perceptions of community-dwelling older women with a risk of falls before and after the installation of a programmable VS. It highlighted the variables that influenced participants' perception of the

programmable VS. In general, they had a positive opinion of the VS. They trusted it to preserve their privacy with the image processing and the time slot programming for the recording. Some participants' perceptions changed during the experiment; concerns related to the presence of cameras (e.g., intrusiveness) lessened, but participants felt uncomfortable receiving visitors during the experiment. Some features and aspects of the implementation procedure positively influenced their experience (e.g., recording on movement detection, programming of time slot). To favour the VS's acceptance and respect users' social life, future research should focus on developing technologies that are not stigmatising.

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