The Effectiveness of Dynamic Guardianship in Promoting a Sense of Safety

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Abstract

Objective: The current study explored the effectiveness of dynamic guardianship, especially moving blinds and speaking CCTV in promoting perceptions of safety as well as lowering perceptions of vulnerability.

Methods: Virtual reality was used to expose participants to the experimental conditions with moving blinds or speaking CCTV. Participants' impressions were collected to analyse the impact of the dynamic guardianship strategies.

Results: The mere presence of the dynamic guardianship did not significantly increase perceived safety or decrease perceived vulnerability. However, willingness to exhibit dynamic guardianship was found relevant for shaping perceptions of safety. Moreover, the dynamic interventions were effective in lowering perceptions of vulnerability among participants with low willingness.

Conclusion: The study highlights the complexity of studying the effectiveness of dynamic guardianship in shaping a sense of safety. However, willingness to exhibit dynamic guardianship played a crucial role for influencing perceptions of safety and vulnerability. Future research should ensure robust implementation of dynamic guardianship manipulations and continue to delve into the complexity of the relationship between dynamic guardians and willingness to exhibit them.

Contents

The Effectiveness of Dynamic Guardianship in Promoting a Sense of Safety

Burglary is a widely feared criminal offence due to its invasive and disturbing nature. Victims of burglaries often report feeling less safe at home, losing trust in others, struggling with sleep, anxiety, depression, or posttraumatic stress disorder (Centraal Bureau voor de Statistiek, 2023). In 2022 alone, a total of 24.396 burglaries were reported in the Netherlands, pressing the need to solve this issue effectively (Netherlands Police Agency, 2023).

Over the years, researchers identified the concept of guardianship to play a crucial role in deterring burglaries. It started with the Routine Activity Theory (RAT) that claimed that burglaries emerge when a motivated offender, a suitable target, and no guardian are present (Cohen & Felson, 1979). Following this idea, Hollis-Peel et al. (2011) defined *guardianship* as "the presence of one or more individuals who can, intentionally or unintentionally, act to deter a (potential) crime event" (p. 54). Based on this, it is believed that, aside from formal guardians such as police or security officers, anyone may be able to serve as a guardian, including neighbours or pedestrians.

Physical Guardianship

In the subsequent years, researchers theorised about a relationship between the occurrence of burglaries and guardianship. For instance, Garofalo and Clark (1992) claimed in their study that the likelihood of being burgled decreases with the number of occupants of the household. Likewise, Bennett (1991) found an association between reduced home occupancy and increased burglary rates. This type of guardianship is known as *physical guardianship,* referring to the deterrence of burglars through the mere physical presence and visibility of a guardian. While many researchers replicated on the effectiveness of physical guardianship (Tilley & Web, 1994; Bennet et al., 2006), it has been identified as rather troublesome for some individuals to monitor or intervene in actual crime situations (Reynald, 2010).

Symbolic Guardianship

To substitute for the potential danger that physical guardians may fear, symbolic guardianship has been found as an innovative solution. Deriving from the work of Hollis-Peel et al. (2011), it has been theorised that guardianship goes beyond the physical presence of guardians. It is believed that guardianship symbols, such as cameras are able to substitute for physical guardians, decreasing the risk of getting harmed.

For instance, research investigating the effectiveness of closed-circuit television (CCTV) surveillance for deterring crime found that potential offenders were deterred by the presence of CCTV (Welsh & Farrington, 2009). It is argued that a camera induces the belief that a guardian is somewhere observing, able to interfere in crime situations (Hollis-Peel et al., 2011). For instance, Piza et al. (2019) argued that CCTV was effective in crime prevention by reducing the opportunity of burglary as well as increasing the perceived risk of being detected.

The observed effectiveness of CCTV in deterring crimes may be linked to what has been found under the term *watching-eyes effect*. It refers to the belief that the display of eyes has the ability to induce a feeling of being watched, influencing individuals to act in prosocial behaviour (Haley & Fessler, 2005; Bateson et al., 2006). For instance, researchers Bateson et al. (2006) conducted an experiment at a communal kitchen of the University of Newcastle, demonstrating that a picture of eyes above a donation box for coffee increased the amount of donations. It is believed that watching eyes have the ability to increase awareness of potential consequences and accountability (Pfattheicher & Keller, 2015).

However, while acknowledging the benefit of symbolic guardianship, one may consider the limitation associated with the use of symbols only. According to Piza et al. (2019), only actively monitored CCTV and not passive ones, were able to deter crimes. Yet,

actively monitored CCTV systems need more investments, including employees, time, and money (Piza et al., 2019).

Dynamic Guardianship as a New Solution

Given the concerns of intervening in physical guardianship and the required investment in actively monitored CCTVs in symbolic guardianship, new solutions are needed to effectively deter burglary. This study seeks to compensate for these issues by introducing a new concept, namely *dynamic guardianship*. The idea of dynamic guardianship is to extend symbolic cues with dynamic features such as sounds or movements. It can be differentiated from symbolic guardianship in terms of their mode. While symbolic guardianship concerns static guardians, dynamic guardianship involves any guardian that can be dynamic. Examples include surveillance cameras with voices, light movements, moving curtains, etc.

With dynamic guardians, humans do not have to put themselves in danger by interfering in crime situations, compensating for the issues associated with physical guardianship. Likewise, the dynamic aspect potentially substitutes for the passively monitored CCTV's as they may promote a feeling of being watched by a guardian. Thus, dynamic guardianship may serve as a new innovative solution for deterring crimes in the future.

Currently, dynamic guardianship lacks significant literature, to the best of my knowledge. However, researchers McClanahan et al. (2024) already made a first attempt in investigating the influence of dynamic guardianship on fear of crime using virtual reality. They have used a motion-activated LED screen to display moving human eyes and the message "burglars we are watching" (McClanahan et al., 2024). They found that the used LED screen caused an increased feeling of being watched as well as reduced feelings of safety (McClanahan et al., 2024). Thus, one may speculate on the potential of dynamic guardians, other than the motion-activated LED screen, in deterring burglaries.

The Current Study

Utilising McClanahan et al.'s (2024) approach to investigate further on the effectiveness of other dynamic guardianship strategies, this study aims at understanding how feelings of safety and security can be fostered. For this purpose, it will be evaluated how effectively dynamic guardianship can promote a sense of security among citizens. The selected strategies concern the usage of moving blinds and dynamic CCTV. It is believed that closing blinds may create the impression of occupancy, someone being at home, able to deter burglary. Likewise, it is suggested that a dynamic CCTV might be able to deter burglary through inducing the feeling of being watched or actively monitored.

The current study will utilise Virtual Reality (VR) to assess how participants view the dynamic guardianship strategies, measured by perceptions of safety and vulnerability to burglary. Additionally, feelings of being watched as well as the willingness to exhibit dynamic guardianship will be assessed. It is believed that willingness plays a crucial role in how participants evaluate perceptions of safety and vulnerability. It originates from the idea that willingness, being an attitude, influences what the participants think about the measures. This can be supported by Marsh & Wallace (2005) who thoroughly examined the influence of attitudes on beliefs. In their work, they have demonstrated that the relationship between beliefs and attitudes is bidirectional, suggesting that attitudes influence beliefs just as beliefs shape attitudes (Mark & Wallace, 2005). Similarly, McGuire (1982) claims that attitudes influence how individuals construct beliefs based on retrieved attitudes from memory. Therefore, one may theorise that high willingness correlates with positive beliefs/perceptions, making it of interest of the current study.

The benefits of using VR reside in the presence effect and experimental control. It is believed that virtual reality has the capability to immerse users into the environment, making them believe to be present (presence effect) (Mithelji et al., 2014). It potentially supports

participants to imagine themselves more easily into the experiment's scenario, leading to accurate perceptions. In criminological research, it was already indicated that VR may offer a more immersive and realistic experience than asking participants to imagine scenarios only (van Gelder et al., 2019). Moreover, the VR setting allows high control over the manipulations and factors involved in the experiment (Sintemaartensdijk, 2022). Thus, researchers can monitor and adjust variables if needed, ensuring accuracy and reliability of the findings.

Hypotheses

H1: The perception of safety increases with the presence of moving blinds or dynamic CCTV, compared to their absence.

H 1.1: The perception of safety increases with the presence of moving blinds or dynamic CCTV, moderated by the feeling of being watched, compared to their absence.

H1.2: The perception of safety increases with the presence of moving blinds or dynamic CCTV, moderated by the willingness of exhibiting dynamic guardianship, compared to their absence.

H2: The perception of vulnerability decreases with the presence of moving blinds or dynamic CCTV, compared to their absence.

H2.1: The perception of vulnerability decreases with the presence of moving blinds or dynamic CCTV, moderated by the feeling of being watched, compared to their absence.

H2.2: The perception of vulnerability decreases with the presence of moving blinds or dynamic CCTV, moderated by the willingness of exhibiting dynamic guardianship, compared to their absence.

Method

Participants and Recruitment

A total of 66 individuals participated in this study, consisting of 34 males, 31 females, and one person who did not prefer to say. The age ranged between 20 and 28 years of age, with a mean of 21 years of age (*SD* = 1.7). Participants were of various nationalities, including Dutch (12.5%), German (21.25%), others (66.25%). The inclusion criteria required participants being over 18 years of age, being proficient in English, as well as being able to attend the experiment. Since all participants met these inclusion criteria, there was no need to exclude participants.

Prior recruitment, this study received ethical approval, indicating accordance with the ethical principles outlined by the Behavioural, Management, and Social Sciences (BMS) ethical committee of the University of Twente. For the recruitment of participants, students were gathered from the University of Twente (UT). The researchers utilised a combination of convenience sampling, selecting participants that are easily accessible, and purposive sampling, collecting participants that meet the inclusion criteria. The recruitment methods included the University's BMS Test Subject Pool SONA, the use of posters, the use of social media (i.e., spreading information about the study), and asking friends from university to participate. Moreover, we attempted to make the participation in this study more lucrative by granting one random selected participant a voucher of 25 Euros.

Research Design

The current study utilised a quantitative approach with perceived safety and perceived vulnerability as dependent variables and dynamic CCTV/blinds as independent variables. Next to that, potentially moderating factors, including the feeling of being watched and the willingness to exhibit dynamic guardianship, were examined. For this purpose, a between-

subjects design was employed, allocating participants randomly to three groups: (1) no manipulation (n =21), (2) moving blinds (n =22), and (3) CCTV with voice (n =23).

Materials

The Virtual Environment

For the development of the virtual environment the Unity Pro programming software (version 2021,3,4f1) was utilised. To view the virtual environment, the Meta Quest 2 headset was used, offering a 360° high-quality virtual environment with moving objects and neighbourhood background noises. Additionally, to navigate through the environment, the participants were provided with game controllers. The virtual neighbourhood consisted of one street with five different looking houses (see Figures 2-6). The houses had terraces, front- and back gardens, and parked cars at front. Participants were able to view the houses from the outside completely and look through the windows, viewing the interior.

Figure 2

Screenshot of House 1

Figure 3

Screenshot of House Two

Figure 4

Screenshot of House Three

Figure 5

Screenshot of House Four

Figure 6

Screenshot of House Five

Dynamic Guardianship Manipulations

The participants were exposed to three conditions, denoted as control-, blinds-, and camera condition. In the control condition, participants explored the virtual environment without any dynamic guardianship manipulations. In the blinds condition, participants experienced how blinds close as soon as they approached houses number one and number four. Visualisation of the blind's manipulation is not possible due to the interactivity of the blinds. Finally, in the camera condition, participants encountered cameras at houses two (see Figure 7) and five (see Figure 8). This camera was dynamic in a sense by stating the following: "Hey, I see you are looking for something, can I help you?", when approaching the main entrance.

Figure 7

Dynamic CCTV at House Two

Figure 8

Dynamic CCTV at House Five

Measures

The crucial measures comprised of manipulations checks, perception of safety, perception of vulnerability, feeling of being watched, willingness to exhibit dynamic guardianship as well as gaming experience, presence, and cybersickness.

Manipulation Checks

To ensure that the dynamic guardianship manipulations were implemented as intended, participants were asked, in an open question, whether they were able to spot any smart home devices during the experiment. To quantify the information, participants that correctly noticed the presence or absence of the manipulations received one point. For instance, participants of the control group, indicating not seeing any SHD, received one point. Likewise, participants of the blinds and camera condition received one point if they detected their manipulation correctly. Conversely, all participants that were unable to detect them were coded as zero. A total of 46 participants correctly identified the manipulations, while 20 did not.

Perception of Safety

To measure perceptions of safety, participants were instructed to rate the following statements regarding the neighbourhood and its residents on a scale from one to five (*strongly disagree-strongly agree).* The following four items derive from the work of Van Sintemaartensdijk, et al. (2021): (1) "Neighbourhood residents know each other well", (2) "Neighbourhood residents look out for each other", (3) "Neighbourhood residents will intervene when they see crime taking place" (p. 662). In addition to these items, participants were asked whether they felt secure walking along in the neighbourhood as well as if they would feel safe living in this neighbourhood. These additional items intend to grasp more information regarding the participant's specific opinion or impression of safety in this VR environment.

This scale was administered two times. First at the beginning, intending to receive the first impression (denoted as Safety1) and after having provided more information regarding smart home devices (denoted as Safety2). This information concerns the following:

> "When talking about securing one's home it is now possible to install items that create the illusion of someone being physically present when in reality nobody is home. Those items are Smart Home Devices (SHD) and can be for example, self-closing blinds, self-switching lights, and ring cameras that allow the owner to communicate with the person in front of it."

Asking two times, does not only allow detecting outliers but also ensures that perceived safety has been sufficiently assessed. The Cronbach's alpha, reliability value of the scale indicates satisfactory internal consistency of the items ($\alpha_{Safety1} = 0.78$, $\alpha_{Safety2} = 0.70$). Overall, participants reported having rather averaged/positive impressions of safety ($M_{Safety1} = 3.7$, $SD_{Safety1} = 0.7$; $M_{Safety2} = 3.7$, $SD_{Safety2} = 0.7$).

Perception of Vulnerability

The perception of vulnerability was measured with the help of a self-constructed two-item scale. The first item intends to assess the perceived risk of burglaries (Vulnerability1, "This neighbourhood is likely to be burgled"), while the second assessed the perceived crime levels, (Vulnerability2, " This neighbourhood appears to have low levels of crime"). The participants had to indicate on a five-point Likert scale their impressions *(completely disagree-completely agree).*

For analysing purposes, the answers on Vulnerability1 were reversed, as the initial high values indicated high perceived vulnerability. Vulnerability2 values remained the same as high scores represented low perceptions of vulnerability. Yet, the analysis revealed a low Cronbach's alpha of the scale ($\alpha = 0.51$). Since this was not known prior the end of the data collection phase, the items were analysed separately. Having reversed the scores on Vulnerability1, participants reported slightly low levels of perceived vulnerability, as indicated by the averaged/moderate means ($M_{Vulnerability1} = 3.4$, $SD_{Vulnerability1} = 1.0$; $M_{Vulnerability2} = 3.9$, $SD_{Vulnerability2} = 0.8$).

Feeling of Being Watched

Deriving from the work from McClanahan et al. (2024), participant's feeling of being watched was measured by the following two statements: (1) "I felt as if I was being watched", and (2) "I felt as if someone else was present in the neighbourhood". This time, participants were instructed to indicate their perception on a scale from one to seven *(completely disagree-completely agree)*. Overall, participants reported an averaged score of feeling of being watched ($M = 3.1$, $SD = 1.6$). The analysis indicated a satisfying Cronbach's alpha for the scale ($\alpha = 0.7$).

Willingness to Exhibit Dynamic Guardianship

The willingness to exhibit dynamic guardianship was measured, likewise Safety2, after having provided the same information regarding the smart home devices (Schlemon, 2024, p.13). After that, 18 questions regarding the participant's general attitude towards dynamic guardianship SHD's were asked (see A3). The 18-item scale was provided by the supervisor and displayed a satisfactory Cronbach's alpha ($\alpha = 0.7$). Overall, the results indicated an average level of feeling of being watched ($M = 3.1$, $SD = 0.4$).

Gaming Experience

Measuring gaming experience of the participants is viewed as essential due to its possible confounding effect on the results. Thus, participants had to indicate in hours per week how often they play games with (1) a controller ($M = 1.4$, $SD = 2.5$), (2) a keyboard ($M = 3.1$, $SD = 5.9$), and (3) a head-mounted VR display ($M= 0.1$, $SD = 0.4$).

Additionally, participants had to evaluate on a two-item scale their expertise (item1, "How experienced are you in dealing with a VR headset/VR game") and confidence with VR (item2, "How confident are you in dealing with a VR headset/VR game"). Participants had to indicate these impressions on a scale from one to five (*beginner-expert*) and displayed an averaged score on game experience ($M = 3.1$, $SD = 1.1$). Finally, the Cronbach's alpha of the gaming experience scale demonstrated a satisfying reliability ($\alpha = 0.76$).

Presence

To measure the presence effect of the virtual environment, the modified version of the Spatial Presence Experience Scale (Hartmann et al., 2016) was utilised (Van Sintemaartensdijk, et al., 2021). This modified version has eight items, intending to measure the presence effect ($M = 3.4$, $SD = 0.8$) constructed by the virtual experience (see A4). Participants were instructed to indicate on a five-point scale to what degree they agree with

the statements (*strongly disagree-strongly agree)*. The scale proved satisfying internal consistency through the Cronbach's alpha, $\alpha = 0.82$.

Cybersickness

Finally, to account for the possibility of cybersickness ($M = 2.2$, $SD = 1.0$) during the virtual reality experience, an adapted version of the Simulator Sickness Questionnaire was utilised (Van Sintemaartensdijk, et al., 2021). It measured the participant's possible discomfort, including nausea, stomach-ache, dizziness, lack of focus, and blurry vision. Participants were instructed to indicate on a scale from one to five *(strongly disagree-strongly agree)* to what extent they were experiencing these discomforts (Van Sintemaartensdijk, et al., 2021). Finally, the Cronbach's alpha ($\alpha = 0.82$) ensured reliability of the scale.

Procedure

Participants have signed up either through the recruitment system SONA or the researchers. The experiment took place in the Flexperiment room at the Behavioural, Management and Social Science (BMS) laboratory of the University of Twente in the Cubicus building.

As a first step, participants are provided with the informed consent, including information about the study context, procedure, potential risks/discomforts, potential benefits, confidentiality, and contact information (see Appendix 1). After consenting to the participation in the study, participants are provided with the scenario in which they have imagine themselves. This scenario instructs participants to imagine wanting to purchase a house which is why they are immersed into the virtual environment (see Appendix 5). After having explained the context of the study, participants have been introduced to the VR glasses and its usage, offering the opportunity to raise questions before entering the virtual environment. With the start of the experiment, participants are randomly assigned to one

condition (no manipulation, moving blinds, or CCTV with voice). After the participants have sufficiently walked around the environment and have viewed all five houses the experiment ends. The devices are returned to the researcher and the participants continue to fill out the questionnaires on the web-based survey platform Qualtrics. Finally, after filling out the questionnaires, the participants were fully debriefed about the purpose of the study (see Appendix 2) and had the opportunity to withdraw their consent for participation.

Data Analysis

For the analysis, the statistical programmes Jamovi (version 2.3.28.0) and R (version 2024.04.1) were utilised. The analysis can be divided into three steps: (1) preliminary analyses, (2) manipulation checks, and (3) main analyses.

The first part of the preliminary analyses focused on testing the psychometric assumptions of the linear model, ensuring reliability and validity of the performed tests. For the linearity and independence of error assumptions residuals plots were constructed. For the homoscedasticity assumption, the Breusch-Pagan test served as a tool. Finally, the Shapiro-Wilk test was used for the normality assumption. Due to violations of the linear model assumptions, non-parametric tests were conducted. The second part of the preliminary analyses investigated on potential confounding effects of the VR components, including gaming experience, presence, and cybersickness. Kruskal-Wallis tests were used to assess the differences between the conditions in terms of the VR components.

The manipulation checks were performed using an independent Chi-square test with Yates Correction for small sample sizes, with noticing SHD as the dependent variable and condition as the independent variable. The Chi-square test was required instead of the Kruskal-Wallis test due to the nature of the dependent variable, being dichotomous (0/1) and not continuous. With a significant value, a subsequent post-hoc comparison followed, using Fisher's Exact test with Bonferroni correction for small sample sizes.

The main analysis attempted to address the hypotheses. Descriptive statistic tests as well as Kruskal Wallis tests were employed to examine the main effects of hypotheses H1 and H2. General linear models were utilised to conduct moderation analysis for hypotheses H1.1, H.1.2, H.2.1, and H.2.2., focusing on moderators, feeling of being watched and willingness to exhibit dynamic guardianship. However, hypothesis H2.2 required further testing due to a significant main of the predictor and an interaction effect. Utilising Jamovi, post-hoc pairwise comparisons were performed for the main effect and simple slopes analysis for the interaction effect.

Results

Preliminary Analyses

To guarantee validity and reliability of the conducted tests, it was crucial to check whether the data violates the assumptions of the linear model. As strong violations of the linearity and normality assumptions were found, non-parametric tests served as a substitute for performing the regression analyses. As an alternative to the Analysis of Variance (ANOVA), the Kruskal Wallis was utilised to assess significant differences between group. Additionally, the Generalised Linear Model (GLM) allowed the construction of the regressions as well as the analysis of moderation/interaction effects.

To control for potential confounding effects of the experiment, differences in terms of gaming experience, presence, and cybersickness were measured. Thus, Kruskal Wallis tests were conducted with these VR factors as dependent and conditions as independent variables. No significant differences were found between conditions in presence, $\chi^2(2, N = 66) = 2.01$, $p = .366$, $\varepsilon^2 = 0.03$; nor in cybersickness, $\chi^2(2, N = 66) = 0.42$, $p = .810$, $\varepsilon^2 = 0.01$; nor in gaming experience, $\chi^2(2, N = 66) = 0.83$, $p = .661$, $\varepsilon^2 = 0.01$.

Manipulation Checks

To ensure that the manipulations were implemented as intended, participants were asked whether they noticed smart home devices (SHD). On average, participants reported noticing SHD less frequently in the control ($M = 0.5$, $SD = 0.5$) and blinds condition ($M = 0.6$, $SD = 0.5$) compared to those in the camera condition ($M = 0.9$, $SD = 0.3$). Further investigation, using a Chi-Square test of Independence with Yates Correction with noticing SHD as dependent and condition as independent variable, showed significant differences between the conditions ($\chi^2(2) = 8.45$, $p = 0.015$, $\varphi = 0.26$.).

To understand these differences further, post-hoc pairwise comparisons were conducted utilising Fisher's Exact test with Bonferroni correction. The results revealed a significant difference between control and camera condition, $p_{Bonferroni} = 0.018$, OR = 0.64, 95% CI [0.16, 2.50]. Non-significant differences were found between control and blinds condition, $p_{Bonferroni} = 1.000$, OR = 1.57, 95% CI [0.40, 6.41], nor between blinds and camera condition, , $p_{Bonferroni} = 0.105$, OR = 5.77, 95% CI [0.95, 63.69]

Main Analysis

H_1: The Perception of Safety Increases with the Presence of Moving Blinds or Dynamic CCTV, Compared to Their Absence

The perception of safety was measured two times, first directly after the experiment (denoted as Safety1) and second after having provided further information regarding smart home devices (denoted as Safety2). Descriptive analysis demonstrated similar means and standard deviations of Safety1 and Safety2 (see Table 1). However, Kruskal Wallis tests with Safety1 and Safety2 as dependent- and condition as independent variables revealed no significant differences between the conditions on Safety 1, $\chi^2(2, N = 66) = 1.19$, $p = .551$, $\varepsilon^2 < .001$, nor on Safety 2, $\chi^2(2, N = 66) = 0.37$, $p = .831$, $\varepsilon^2 < .001$.

Table 1

Descriptives on Safety1 and Safety 2

Variables	Condition	*M*	*SD*
Safety 1(pre – SHD information)			
	Control	3.9	0.5
	Blinds	3.6	0.7
	Camera	3.6	0.8
Safety 2 (post – SHD information)			
	Control	3.9	0.5
	Blinds	3.7	0.9
	Camera	3.7	0.5

H 1.1: The Perception of Safety Increases with the Presence of Moving Blinds or Dynamic CCTV, Moderated by the Feeling of Being Watched, Compared to Their Absence

To assess the potentially moderating effect of the feeling of being watched on the perception of safety, the GLM was utilised. The dependent variables were Safety1 and Safety2, and the independent variables were condition and feeling of being watched. For Safety1, the results revealed no significant main effects of the condition, b = -0.13, $t(62)$ = -0.64, SE = 0.21, p = .524, β = -0.13, nor of the feeling of being watched, b = -0.09, $t(62)$ = -1.045, SE = 0.09, p = .300, β = -1.05. Likewise, no significant interaction effect was found between condition and feeling of being watched, b = -0.00, $t(62)$ = -0.01, SE = 0.60 p = .996, β < .000.

For Safety2, the findings displayed similarly no significant main effects of the condition, b = 0.06, $t(62)$ = -0.30, SE = 0.21, p = .762, β = 0.30, nor of the feeling of being watched, b = 0.00, $t(62)$ = 0.05, SE = 0.09, p = .962, β = 0.05. Additionally, no significant interaction effect was observed between condition and feeling of being watched, b = -0.02, $t(62)$ = -0.37, SE = 0.06, p = .716, β = -0.37.

$H_{1.2}$: The Perception of Safety Increases with the Presence of Moving Blinds or Dynamic CCTV, Moderated by the Willingness of Exhibiting Dynamic Guardianship, Compared to Their Absence

A GLM with perceived safety as dependent variable and condition and willingness to exhibit dynamic guardianship as independent variables, revealed partly significant results. For Safety1, non-significant main effects of the condition (b = -1.21, $t(62)$ = -1.62, SE = 0.74, p = .111, β = -1.62) and willingness to exhibit dynamic guardianship (b = 0.20, $t(62)$ = 0.55, SE = 0.37, p = .581, β = 0.55) were found. Likewise, no significant interaction effect, b = 0.35, $t(62)$ =1.41, SE = 0.25, p = .165, β = 1.41.

For Safety2, the findings displayed a significant main effect of the moderator, willingness to exhibit dynamic guardianship, b = 0.91 , $t(62)$ = 2.50, SE = 0.37 , p = 0.015, β = 2.50. However, the main effect of the condition, b = 0.52 , $t(62)$ = 0.72, SE = 0.73 , p = 0.473, β = 0.72, as well as the interaction effect was non-significant, b = -0.19 , $t(62)$ = -0.76, SE = 0.24 , p = 0.448 β = -0.76.

H_2: The Perception of Vulnerability Decreases with the Presence of Moving Blinds or Dynamic CCTV, Compared to Their Absence

To recall, the two-item scale that intended to measure the perception of vulnerability had a low Cronbach's alpha of 0.65, indicating low internal consistency. Thus, each item was analysed separately. Item1 is denoted as Vulnerability1 and Item2 as Vulnerability2. This should not be confused with Safety1 and Safety2, as they represent repeated measures.

Proceeding to the findings, descriptive analysis showed a similar mean and standard deviation across the conditions for Vulnerability1 and Vulnerability (see Table 2). Additionally, the Kruskal Wallis test with Vulnerability1 as dependent variable and condition as independent variable was performed. The results revealed that there is no significant difference in Vulnerability1 across the conditions ($\chi^2(2) = 1.79$, p = .408, $\varepsilon^2 = 0.04$).

Likewise, the Kruskal Wallis test with Vulnerability2 as dependent variable and condition as independent variable, demonstrated a non-significant effect of the condition on Vulnerability2, (χ^2 (2) = 1.26, p = .53, ε^2 =0.03).

Table 2

Descriptives of Vulnerability items

Variables	Condition	*M*	*SD*
Vulnerability 1			
	Control	3.6	0.9
	Blinds	3.3	0.9
	Camera	3.3	1
Vulnerability 2			
	Control	4.1	0.9
	Blinds	3.9	0.7
	Camera	3.9	0.9

$H_{2.1}$: The Perception of Vulnerability Decreases with the Presence of Moving Blinds or Dynamic CCTV, moderated by the Feeling of Being Watched, Compared to Their Absence

Utilising the GLM with perceived vulnerability as dependent variables and condition and feeling of being watched as independent variables, revealed no significant results. No significant main effect of the condition on Vulnerability1, b = -0.23 , t(62) = -0.76, SE = 0.31 , p = .451, β = -0.76, nor of the moderator, feeling of being watched was found, b = -0.00, t(62) = 0.00, SE = 0.12 , p = .997, β = 0.00. Likewise, no significant interaction effect between the moderator and dependent variable was found, b = 0.15 , t(62) = 0.18, SE = 0.09, p = .862, β = 0.18.

Similar effects were found for Vulnerability2. The GLM indicated no significant main effect of the condition on Vulnerability2, b = -0.00, t(62) = -0.02, SE = 0.26 , p = .983, β = -0.2, no significant main effect of the feeling of being watched, b = 0.03, t(62) = 0.31, SE = 0.11 , p = .768, β = 0.31. Additionally, no significant interaction effect of condition and

feeling of being watched was observed, b = -0.03, $t(62)$ = -0.37, SE = 0.08 , p = .716, β = -0.36.

$H_{2.2}$: The Perception of Vulnerability Decreases with the Presence of Moving Blinds or Dynamic CCTV, Moderated by the Willingness of Exhibiting Dynamic Guardianship, Compared to Their Absence

The GLM with perceived vulnerability as dependent variable and condition and willingness to exhibit dynamic guardianship revealed partly significant results. For Vulnerability1, the main effect of the condition was significant, b = -3.06, $t(62)$ = -2.97, SE = 1.03 , p = 0.004, β = -2.97. Likewise, a significant interaction effect between condition and the willingness to exhibit dynamic guardianship was found, b = 0.96, $t(62)$ = 2.80, SE = 0.34, $p < 0.05$, β = 2.80. However, no significant main effect of the moderator, willingness to exhibit dynamic guardianship was found, b = -0.52, $t(62)$ = -1.01, SE = 0.51, p = .319, β = -1.01

For the significant main effect of condition, post hoc comparisons were performed. However, these results displayed non-significant differences across the conditions: (1) control vs. blinds, $t(60)$ = 1.06, SE = 0.27, $p_{Bonferroni}$ = 0.878, OR = 2.89, (2) control vs. camera, $t(60)$ = 1.06, SE = 0.27, $p_{Bonferroni}$ = 0.480, OR = 51.34, and (3) blinds vs. camera, $t(60)$ = 0.36, SE = 0.27, $p_{Bonferroni}$ = 1.000, OR = 3.78.

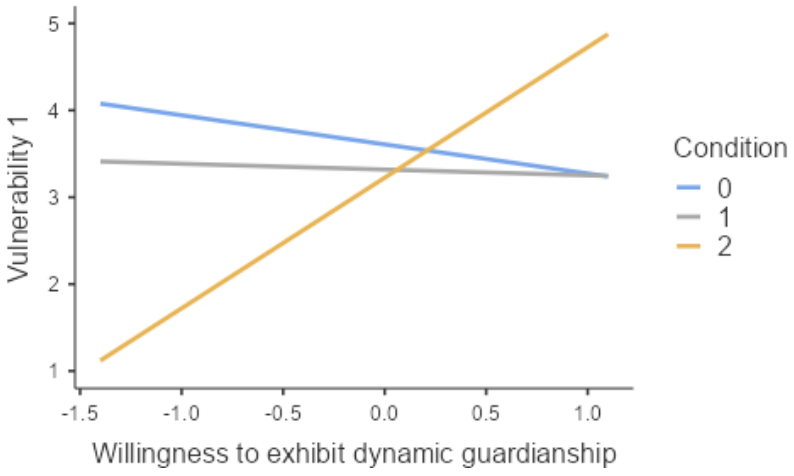
For the significant interaction effect between condition and the willingness to exhibit dynamic guardianship, simple slope analysis was conducted. At low levels of willingness to exhibit dynamic guardianship (-1SD below the mean), participants showed a significant difference between the conditions on Vulnerability1, b = -0.54, $z(60)$= -2.95 SE = 0.18, p = 0.003, 95% CI [-0.91, -0.18]. At averaged and high levels of willingness no significant differences were detected between the conditions on Vulnerability1, mean (b = -0.19, $z(60)$=

-1.37, *SE* = 0.14, p = 0.171, 95% CI [-0.45, 0.08], high (+1SD, *b* = 0.16, *z*(60)= 0.89, *SE* = 0.18, p = 0.373, 95% CI [-0.21, 0.53].

The interaction effect is further illustrated in Figure 9. It demonstrated how Vulnerability1 differs across the conditions while considering the level of willingness. The camera condition revealed a strong positive trend between willingness and Vulnerability1, lower willingness is associated with lower perceived vulnerability. Conversely, high willingness is associated with higher perceived vulnerability. The control and blinds condition both indicated that as willingness increases, perceived vulnerability slightly reduces. Thus, changes in willingness did not affect perceptions of vulnerability in the control and blinds condition.

Figure 9

Interaction Effect of Willingness and Condition on Vulnerability1



Note. Conditions, 0 = control, 1 = blinds, 2 = camera.

For Vulnerability2, no significant effects were found neither of the main effect on the condition *b* = -1.29, *t*(62) = -1.32, *SE* = 0.97, *p* = .191, β = -3.15, non on the willingness to exhibit dynamic guardianship, *b* = -0.38, *t*(62) = -0.79, *SE* = 0.49, *p* = .434, β = -1.07, nor an interaction effect, *b* = 0.40, *t*(62) = 1.24, *SE* = 0.32, *p* = .221, β = 2.97.

Discussion

The current study explored how dynamic guardianship can be utilised to promote a sense of safety and lessen impressions of vulnerability to burglary. In addition, it was assessed how feelings of being watched and willingness to exhibit dynamic guardianship may influence these perceptions of safety and vulnerability. Virtual reality was used to expose the participants to moving blinds and dynamic CCTV. From a citizen's perspective, participants had to report their impressions, allowing for analysis and evaluation of the dynamic guardianship strategies. The study's results are suggesting some valuable insights.

It was found that willingness to exhibit dynamic guardianship positively influences perceptions safety, but only after having provided information regarding smart home devices (H1.2). However, the presence of the dynamic guardians did not influence how willingness affected perceptions of safety. Likewise, willingness was associated with perceiving the neighbourhood as less vulnerable to burglary (H2.2). However, willingness alone did not predict perceptions of vulnerability, but influenced the effectiveness of the dynamic guardians at low levels of willingness. The dynamic guardians were less successful in reducing perceptions of vulnerability for those who are averaged or highly willing to exhibit them.

Furthermore, the dynamic guardians were not able to independently improve perceptions safety (H1), nor did they diminish perceptions of vulnerability to burglary (H2). Finally, the participants did not report significant feelings of being watched (H1.1 & H2.1), nor did it moderate the effects of the dynamic guardians on perceived safety or vulnerability.

The Role of Willingness in Shaping Perceptions of Safety and Vulnerability

In this study, willingness to exhibit dynamic guardianship plays a crucial role in forming perceptions of safety and vulnerability. It aligns with the findings of other researchers claiming that attitudes influence how beliefs are formed (McGuire, 1982; Mark

&Wallace, 2005). The findings indicate that willingness to exhibit dynamic independently predicts positive perceptions of safety, but only after having provided more information regarding smart home devices. This suggests a confounding effect of the provided information in shaping perceptions of safety. It could be argued that after having prompted smart home devices with additional information, participants were reconsidering their impressions. Hence, the information specifically mentions that it imposes the impression of a guardian being present, participants were shown one potential benefit of SHD, thus forming a positive attitude towards it. This idea can even be supported by other researchers. For instance, Davis (1985) demonstrated that perceived usefulness influences attitude formation and leads to intentions of usage.

Alternatively, one may claim that the information about SHD captured the attention of the participants in the first place, attuning participants to perceptions of safety. This belief may be supported by the Attention Control Theory (ACT), proposed by Posner (1990). The theory claims that attention is controlled by either goal-driven stimulus or external stimulus (Posner, 1990). As such one may argue that the information about SHD acted as an external stimulus, heightening the awareness towards safety perception. This underscores the importance of mentioning SHD information, including its protective properties for forming perceptions of safety.

Moving forward, willingness to exhibit dynamic guardianship was associated with a reduced perception of vulnerability to burglary. Yet, willingness alone did not predict a reduced perceived vulnerability but altered how the dynamic guardians have been perceived. Surprisingly, the findings suggest that, only at low willingness to exhibit dynamic guardianship, participants perceive the neighbourhood as less vulnerable. It contradicts findings of Sampson et al. (1997) and Reynald (2010), who found that in neighbourhoods where residents are more willing to supervise or intervene, lower crime rates have been

reported. Thus, one may suggest that other factors are more significantly contributing to perceptions of vulnerability.

For instance, participants might have adjusted their perceptions of vulnerability to the presence of dynamic manipulations rather than their personal attitudes towards dynamic guardianship. This may explain the non-significant main effect of willingness and the significant interaction effect with the condition. Besides, it suggests the presence of dynamic cameras or moving blinds may influence vulnerability perceptions, potentially overlooking the influence of willingness.

This may align with the effectiveness of both moving blinds and dynamic CCTV in decreasing perceptions of vulnerability to burglary, within the moderation analysis, compared to no manipulation. Yet, continued analysis revealed that there is not enough evidence to identify which of the dynamic guardianship strategies was more effective. Thus, moving blinds and dynamic CCTV might be equally effective in lowering perceptions of vulnerability. The results highlight that willingness alone might not diminish perceptions of vulnerability to burglary, yet under certain conditions. Yet, it remains crucial to understand the influence of willingness on perceptions of safety and vulnerability. As other researchers already highlighted, willingness to intervene in crime situations is associated with low crime rates (Reynald, 2010).

Finally, while willingness affected the perceived vulnerability of the environment, it did not influence how participants perceived the levels of crime in the neighbourhood. It might be more challenging for participants to guess crime levels than a general impression of vulnerability. Participants may differ in how they view crime levels and may associate crime levels with differing factors. Reichert and Konefal (2017) explain in their paper that individual perceptions of crime are influenced by personal experience. For instance, they have found that residents from socially disorganized neighbourhoods report high levels of

fear of crime (Reichert & Konefal, 2017). Thus, personal experiences as well as how individuals imagine neighbourhoods with high crime rates possibly contributed to the inconclusive findings on perceptions of vulnerability.

Dynamic Guardianship and Perceptions of Safety and Vulnerability

Contrary to expectations, the study revealed that the dynamic guardians do not independently shape perceptions of safety or vulnerability. However, while one can argue that the dynamic guardians did not affect at all perceptions of safety, the opposite could be claimed for perceived vulnerability. The interaction effect between the dynamic guardianship manipulations and willingness to exhibit dynamic guardianship may suggest other underlying reasons for the non-significant results.

The manipulation checks may offer some insight into the supposed ineffectiveness of the dynamic guardians in shaping perceptions of safety and vulnerability. It was found that participants less accurately detected the moving blinds than the speaking camera, indicating implementation issues and possibly altered results. Deriving from the researchers' observations, some participants in the moving blinds manipulation approached the doors from an angle at which they were not able to see the closing blinds.

Furthermore, one may consider the study's design as it focuses on the perceptions of citizens. It may not always accurately reflect actual safety or vulnerability. As demonstrated by researchers Nee and Meenaghan (2006), unlike citizens, burglars evaluate potential burglary targets based on environmental cues or experiences, considering factors such as socio-economic status, accessibility, security, and so on. Thus, it might be that burglars would have more accurately detected the blinds than the citizens of the study.

Alternatively, participants possibly missed the moving blinds due to limited environmental cues. In comparison to the moving blinds, the camera had an additional acoustic element causing participants to receive visual and acoustic environmental cues. This

can be linked to similar findings of Yang et al. (2020), claiming that combining visual cues with spatial auditory cues increased spatial awareness. Likewise, studies claim that voices cannot be easily ignored, increasing feelings of safety due to a belief that someone else might be present (McClanahan et al., 2024; Biocca et al., 2003).

Furthermore, while it was assumed that moving blinds and dynamic CCTV may shape impressions of safety and vulnerability, it might even be that it causes the opposite. As explained by Marx (1988) extensive security measures may be perceived as distrust from neighbours, causing an overall lower sense of safety. Based on this idea, it could be argued that there are no significant differences across the conditions in terms of perception of safety or vulnerability due to attitudes or beliefs the participants hold. For instance, Austin et al. (2002) found that direct victimisation or contact with victims negatively affects perceptions of safety (Austin et al., 2002). Thus, a confounding effect of past experiences in shaping perceptions of safety can be assumed. Likewise, the study highlighted that the character trait "fear of crime" highly contributes to perceptions of safety (Austin, et al. 2002). Thus, it could be argued that individual differences in terms of past experiences as well as character traits may better explain how impressions of safety are formed. This explanation would align with what has been previously stated, individuals may also evaluate vulnerabilities based on past experiences. As Reichert & Konefal (2017) highlighted, participants from socially disorganised neighbourhoods have higher levels of fear of crime and, thus are more fearful towards vulnerabilities.

Feeling of Being Watched and Perceptions of Safety and Vulnerability

Contrary to expectation, the present study found that neither moving blinds nor the dynamic CCTV induced feelings of being watched, influencing perceptions of safety and vulnerability. From this perspective, it could be argued that either the dynamic guardians

failed to produce a feeling of being watched or that other factors came into play, changing the effect.

Comparing the current study with McClanahan et al.'s (2024) motion-activated LED, one may suggest that the manipulation failed to promote feelings of being watched due to unsubtle and ambiguous strategies. As indicated before, the moving blinds were less accurately detected and might possess limited cues for promoting an impression of being watched. Alternatively, concerning the dynamic CCTV, participants' past experiences as well as their personality may have interfered, influencing feelings of being watched (Reichert & Konefal, 2017; Austin et al., 2002).

Strengths and Limitations

The current study offers several strengths as well as limitations which need to be addressed. While research on dynamic guardianship is rather limited, this study entered unknown territory, achieving valuable insights into the importance of willingness. Besides, it sheds light on the complexity of forming perceptions of safety or vulnerability. Apart from that, one may evaluate the use of virtual reality as an innovative approach towards investigating burglaries, aligning with other researchers (van Gelder et al., 2019).

Despite the unique approach of this study, it found its limitations in terms of implementation as well as generalisability. The implementation issues with the moving blinds, combined with the inconclusive results regarding the role of the dynamic guardians, highlight the need for careful interpretation of the findings as well as for a better understanding of the factors involved in shaping perceptions of safety or vulnerability. Finally, the study's reliance on self-reports from a citizen's perspective may cause potential bias, such as social desirability (i.e., the tendency to provide only socially desired answers) (Grimm, 2010) as well as a limited reflection of the reality due to the perspective.

Future Research

For future research, utilising VR, it is crucial to ensure that the manipulations are correctly implemented. For this purpose, researchers should ensure prior to the experiment that participants are not able to miss the manipulation. This can be done by combining the visual cue of moving blinds with acoustic cues, yielding at effectiveness of the dynamic guardian. Alternatively, one may ensure an encounter with the dynamic guardians by manipulating the virtual environment in such a way that participants will see the guardian at any house independently of the participant's walking patterns. This was already achieved by other researchers who utilised VR in studying burglaries (van Sintemaartensdijk et al., 2021).

Furthermore, future research should continue investigating the role of willingness as the current study only found inconclusive results findings. Yet, based on the findings of Reynald (2010) on the impact of willingness for probabilities of intervening in crime situations, future research should view willingness as an important predictor. Likewise, researchers could further delve into the impact of information on dynamic guardians in promoting feelings of safety.

Finally, future research should make more efforts in assessing the factors involved in forming perceptions of safety or vulnerability. Therefore, researchers should focus on the effects of past experiences. It might be valuable to understand how the own reference frame contributes to the perceptions of safety or vulnerability as well as how it might influence the effectiveness of the dynamic guardians in deterring actual burglars. For instance, it was already suggested that participants from socially disorganised neighbourhoods are more fearful, thus having a higher perceived vulnerability to burglary.

Conclusion

To conclude, this study provides insights into the effectiveness of dynamic guardianship, especially speaking CCTV and moving blinds, on the perception of safety and vulnerability. Even more, it explored potential moderators, including the feeling of being watched. While the study was not able to prove the assumptions, it allowed to identify the crucial role of willingness to exhibit dynamic guardianship for the promotion safety and vulnerability. Ultimately, this study opened the path towards investigating the effectiveness of new, potentially, innovative solutions for deterring burglaries. As such one may only speculate on how dynamic guardianship will redefine the means of security for the future.

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Appendix

Appendix 1

Informed Consent of the current study

Dear participant,

Thank you for choosing to participate in this study. The study aims at looking into how citizens perceive the safety of Dutch neighbourhoods, and what we can learn from these perceptions in order to create better deterrent measures to deter burglars.

Procedure

Participation in this study takes maximum 45 minutes. You will walk around a neighbourhood using a virtual reality headset and to tell us what you think of this neighbourhood. Afterward you will answer questions on the realism of the neighbourhood and how you perceived this neighbourhood.

Potential Risks and Discomforts

There are no obvious physical, legal, or economic risks associated with your participation in this study. If, however, you feel a little nauseous due to being in virtual reality you can always stop or pause the study.

This research was reviewed and approved by the BMS Ethics Committee of the University of Twente. For questions or problems regarding ethics of the study, the Secretary of the Ethics Commission of the faculty Behavioural, Management and Social Sciences at University Twente may be contacted through ethicscommittee-bms@utwente.nl.

Potential Benefits

If you have signed up over SONA you will receive 1.5points for participation.

Confidentiality

Your privacy will be protected to the maximum extent allowable by law. Since your responses are completely anonymous, no data, such as names, is being collected that can be

traced back to you. Your response is only used for scientific research. In case of a withdrawal, your data will be deleted immediately.

Right to Withdraw and Questions

Your participation is voluntary. If you participate, you may decide to withdraw from the study at any time. You will not be penalized or lose any benefits to which you otherwise quality if you decide to not to participate or to stop participating. If you have questions or concerns regarding this research, please contact us.

Contact Information

Dr. Iris van Sintemaartensdijk (i.vansintemaartensdijk@utwente.nl)

Statement of Consent

By checking the box below, you confirm that you are at least 18 years of age, you have read and understood all the information, give your consent, and that you voluntarily agree to participate in this study.

- I have been sufficiently informed about the study and all my questions are answered to my satisfaction
- I have the right to withdraw from the study at any time
- I have understood that no personally identifiable information will be reported in the research report and confidentiality is ensured

If you do not agree to this, end the study by leaving the website.

Appendix 2

Debriefing of the current study

Thank you for participating in this study.

In this study, we looked at the perceptions of citizens on safety of neighbourhoods. For the purpose of this study, we did not tell you that you were in one of four conditions where dynamic guardians were placed in the neighbourhood.
A dynamic guardian is the combination of a physical guardian, such as a person being present in front of the house, and a symbolic guardian, such as a sign indicating a neighbourhood has a Neighbourhood watch group. In the context of the study the dynamic guardian was a technical device that was supposed to leave the impression that a person was home when in reality nobody was in the house. This could either be automatic lighting in a house, curtains that were closed or a camera with sound. You could also have been allocated to the control condition where no such measures were present.

We want to see if people feel more safe in a neighbourhood when such measures are present, or if these measures make people feel as if a neighbourhood is less safe because there are many protection measures.

Please do not share the content of this study with other potential participants to allow them an unbiased view in case of participation.

Do you have any other question right now? Please let the researchers know who are present now. If more questions arise later, you can contact Dr. Iris van Sintemaartensdijk (i.vansintemaartensdijk@utwente.nl)
If you now feel like you would rather withdraw your consent of participation and usage of you data you can says so now.

Appendix 3

Scale for measuring the willingness to exhibit dynamic guardianship

Statements
1. Not using SHD is a serious threat to my safety.
2. The longer you wait to install an SHD, the greater the likelihood of a burglary.
3. If I do not install an SHD my home is at a higher risk of getting burgled while I am away.
4. I am partially responsible if my house gets burgle if I do not have an SHD installed.
5. I can protect my own resources, such as free time and energy, by installing SHDs.
6. I can still protect myself from a burglary even if I do not install SHDs.
7. It is more convenient to rely on other preventative measures of burglary than SHDs.
8. It will save me money if I do not install an SHD.
9. I can avoid the hassles of installing an SHD.
10. I will save myself time by not installing a SHD.
11. I will be less concerned about my privacy if I do not install an SHD.
12. I will not become a victim of burglary if I install an SHD.
13. The surrounding neighbourhood will be safer after I installed an SHD.
14. The attractiveness of my home to a burglar will decline if I install an SHD.
15. I will be able to find a suitable SHD to install at home.
16. I have the skills to install an SHD if necessary.
17. My friends will believe that I am protected against burglaries if I use and SHD.
18. My neighbours or people that live with me will not appreciate it if I install SHDs.

Appendix 4

Modified Presence Scale (Van Sintemaartensdijk, et al., 2021).

Statements
1. I felt like I was actually in the virtual neighbourhood
2. I felt like I was part of the virtual environment
3. It felt like I was physically present in the virtual environment
4. The items in the virtual environment gave me the feeling I could use them
5. I felt I could be active in the virtual environment
6. I felt I could move around the items in the virtual environment
7. It felt like I could do anything I wanted in the virtual environment
8. I felt like I was actually in the virtual neighbourhood

Appendix 5

Description of the Scenario

In a few moments you will experience a VR scenario, where you will walk around a virtual neighbourhood.

We want you to image you are in the market to buy a new house. You have been saving for a while and have finally decided to make this significant investment. Today, you will walk around in a neighbourhood to see if this is the right neighbourhood for you. We ask you to walk around and see if there are any houses that would suit you. After you are done, we ask for your preferences, and judgement of the neighourhood.