Reframing dynamic guardianship – a virtual reality study

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Abstract

Guardianship in the context of reducing crime from taking place has shown its effect in recent years. Previous experimental research has primarily investigated symbolic and physical guardianship but so far not dynamic guardianship. Dynamic guardianship describes a combination of the former two guardians. However, it does not require the presence of a person but intends to leave the impression that someone is around. This study examines the effects of dynamic guardianship on the scouting behaviour of burglars, measured by looking at the distance walked, and time spent in a VR neighbourhood. 125 participants, consisting of university students, were asked to take on the role of a burglar while scouting a neighbourhood for a suitable burglary target. While in the neighbourhood, participants were randomly exposed to one of three levels of guardianship (self-switching lights, self-closing blinds, smart camera audio) or no guardianship. A scale to measure dynamic guardianship from the burglars' and residents' perspective was developed. The burglars' perspective aimed at exploring the burglars' focus when scouting the neighbourhood for targets. Moreover, the residents' perspective aimed at getting an understand of the attitude towards Smart Home Devices (SHD), after being exposed to them in the environment through the dynamic guardians. The presence of dynamic guardianship in the neighbourhood had no effect on the scouting behaviour of participants. Most influential on the burglars' target selection in the neighbourhood was the target's perceived activity level. Further, it appeared that residents were most concerned about their freed resources (such as time) in relation to acquiring SHD, that potentially deter burglars. The dynamic guardians selected for this study appeared to not deter burglars. However, their experience from scouting the neighbourhood provided insight into the focus of a burglar when deciding whether to target a house or not. The developed dynamic guardianship scale is a good starting point for measuring dynamic guardianship and after some refining touches can be used for future research.

Keywords Dynamic guardianship, burglary, deterrence, virtual reality, smart home devices

Reframing dynamic guardianship – a virtual reality study

After a continuous decline of burglary cases over the last ten years in the Netherlands, its lowest point was reached in 2021 during the climax of the COVID-19 pandemic (Statista Research Department, 2013; Three years of COVID-19 in figures, 2023). However, newer numbers indicate a clear increase of cases aligning the lifting of regulations related to the pandemic. In 2022, roughly 1,000 more cases had been reported in comparison to the previous year (Statista Research Department, 2013). This can potentially be explained by people going back to working face-to-face instead of remotely, as well as being able to socialise more outside of the own home (Three years of COVID-19 in figures, 2023). In Enschede alone there has been noted an increase of its burglary rate by 75% from 2021 to 2022 (Haverkate, 2022).

The increasing burglary rate is concerning as the burglaries impact the well-being of citizens (CBS, 2023). When being asked about the influence home burglary including theft has on them, 63% of Dutch citizens have reported to be feeling less safe in their own home, alongside 28% mentioning having trouble sleeping. As a result, 41% of victims of burglaries addressed having less trust in others. Furthermore, financial problems are a major consequence when items have been stolen (17%). According to the Central Bureau of Statistics (CBS; 2023), damage caused by burglaries including theft have been over 160 million euros in 2021, which were only partially covered by insurance.

Under which circumstances burglars are most likely to burgle can be explained using Cohen and Felson's (1979) Routine Activity Theory (RAT). Their theory describes the interplay of *a suitable target*, *a likely or motivated offender* alongside *the absence of a capable guardian*. This combination is said to predict when crime is most likely to happen alongside providing information of how to prevent burglaries from taking place (Cohen & Felson, 1979; Miró, 2014). Instead of looking at characteristics of possible offenders, RAT is assessing changes in the patterns occurring in relation to a crime taking place (Cohen & Felson, 1979). It further states that the more elements of the theory are present, the higher the chance of a criminal event taking place (Cohen & Felson, 1979). Contrasting, the absence of those elements has a direct impact increasing the likelihood of a criminal event taking place (Cohen & Felson, 1979). Additional research conducted about the elements of RAT have placed great emphasis on the importance of a capable guardian in order to prevent crime (Hollis et al, 2013; Hollis-Peel et al., 2014).

Guardianship

Guardianship is described as the presence of an individual who performs deterring behaviour which keeps a potential crime from taking place (Hollis-Peel et al., 2011). It is crucial for a guardian to be available and able to monitor their environment (Hollis-Peel et al., 2011). Existing research has found that the more guardians are found in a neighbourhood, the lower the crime rate in said neighbourhood (Cohen & Cantor, 1981; Miethe et al., 1987). Further, it is said that the presence of a guardian is a robust deterring factor for potential burglars (Coupe & Blake, 2006; Cromwell et al., 1991; Wright et al., 1995). As both Reynald (2009) and Cohen and Felson (1979) already touched upon, the concept of guardianship has been increasingly researched in the last years. A guardian describes the impact an individual has on stopping a crime from taking place (Hollis-Peel et al., 2011). This is executed by somebody present in the environment to take on the role of a guardian who is either actively or passively stopping a crime from taking place. This is supposed to leave the suspicion that potential criminal behaviour can be observed (Reynald, 2009; Hollis et al., 2013).

A physically present individual taking on the role of a guardian to intervene on crime is defined as *physical guardianship* (van Sintemaartensdijk et al., 2022). The structures underlying the activities performed by a physical guardian can be further explained by Reynald's (2009) three successive levels of guardianship. The first level entails the mere presence of a guardian. The second level describes guardians actively monitoring surrounding. Followed by the third level reporting guardians actively monitoring surroundings and intervene when they observe a potential offender. The presence or absence of those steps has a direct influence on the whether or not a crime event is taking place (Reynald, 2009; Cohen & Felson, 1979).

Even though there is overwhelming evidence for the successful reduction of crime events taking place due to physical guardianship, a permanent availability of such guardians is not feasible. The shortcomings of physical guardianship can be counteracted with the help of symbolic guardianship. The most prime examples of *Symbolic guardianship* describe the use of signs and closed-circuits cameras (CCTV) in order to deter potential offenders (Hollis-Peel et al., 2011). Previous research has facilitated the 'watching eyes effect' by using images of eyes to create the illusion of being watched in order to reduce antisocial behaviour (Bourrat et al., 2011; Cai et al., 2015; Pfattheicher & Keller, 2015). Further, neighbourhood watch signs or police signs leave the impression that an area might be monitored by someone and deter burglars from committing a crime (van Sintemaartensdijk et al., 2022). This kind of guardianship increased the level of concern about possibly being observed while providing no

information about whether or not that is actually the case (Jones & Pridemore, 2019; Hollis et al., 2013). Nevertheless, symbolic guardianship cannot interact with potential offenders making it less successful in deterring them in comparison to physical guardianship (van Sintemaartensdijk et al, 2022). Thus, a new kind of guardianship, which is combining the deterring effects of physical and symbolic guardianship, was needed.

This idea resulted in the creation of dynamic guardianship. *Dynamic guardianship*[1] is leaving the impression that somebody is home when in reality nobody is there. This is done by mimicking different kinds of behaviour that are commonly performed by people in their homes and perceived as a clear indication of somebody being physically present by offenders. Further, the help of technology is needed to bring devices to life that execute movements without the presence of a physical person. Switching on lights, closing blinds and camera surveillance are ideas for such devices that are worth looking into. As a result of that, dynamic guardianship is counteracting the inability of symbolic guardians to interact and the unavailability of physical guardians to be present at all times.

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[1] In the context of this study, the terms dynamic guardianship and dynamic guardian will be used interchangeably. Both refer to devices that leave the impression of somebody being home when in reality nobody is there, and thus describe mimicry, but no actual physical presence.

Dynamic guardianship devices

There is no research looking into dynamic guardianship yet, which is why we are looking into it an optimal measure for it. Three dynamic guardians were chosen to further explore in the context of this study. The first two dynamic guardians used in this study are self-switching lights and self-closing blinds. Previous research has indicated that burglars prefer unoccupied targets and are deterred by physical activity displayed inside the potential target (Montoya et al., 2014). The impression of someone being home is often displayed by lights and visibly performed movement (Reynald & Elffers, 2009; Montoya et al., 2014). Especially self-closing blinds can be expected to successfully deter burglars as they not only mimic physical movement in the house but additionally reduce the visibility of what kind of activities are going on in the house (Montoya et al., 2014). Therefore, it can be expected that devices, such as self-switching lights and self-closing blinds mimic enough movement in a house to deter potential burglars without needing to display a physical guardian. The idea is that both dynamic guardians are paired with a sensor that is detecting motion in a selected zone around the house (Tan et al., 2019; Zaman et al., 2017). They are different to common devices that are triggered by a timer, because these guardians are only activated through the presence of motion and are therefore truly dynamic. Once somebody is entering the zone, the installed dynamic guardian gets triggered.

Lastly, the effects of a smart camera including an audio which is mimicking being approached by the homeowner will be studied. Previous research has already confirmed the decreasing effect a CCTV camera has on crime, for both active and passive surveillance (Welsh & Farrington, 2009; Piza et al., 2019). However, a regular CCTV camera is not truly dynamic as it is either active or not. We will take one step further and use a smart camera for this study instead, which is actively engaging with its environment. A smart camera is a smart device accessible to the greater public and can be installed on one's property (ring, n.d.). This kind of camera is set up on an App on the owner's smartphone and connects to Wi-Fi. It differs in comparison to a CCTV camera, since it detects movement, which is followed by recording the area it is covering while simultaneously sending a message to the owner. It is then possible to examine the area recorded by the camera over the smartphone with the additional option of speaking to whomever is present in the location covered by the camera.

It can be expected that the use of a smart camera including an audio has a deterring effect on possible burglars. This assumption is substantiated by findings indicating that the mere presence of CCTV cameras is leaving the impression that somebody could potentially monitor the neighbourhood (van Sintemaartensdijk et al., 2022). This effect is further

specified by stating that even if it is unclear to the burglar whether or not the recordings are actually watched the deterring effect remains stable (van Sintemaartensdijk et al., 2022). Further research has looked into the effects of mismatching the appearance and the voice of virtual characters in VR and its effects on the user's perception of those characters (Zibrek et al., 2021). Their findings stated that an unexpected mismatch of voice and appearance in characters lead to a negative emotional reaction and feelings of discomfort towards the character. When linking this to our smart camera with a human voice audio, the unexpected link of the voice to the camera might be enough of a mismatch to trigger feelings of discomfort leading to a deterring effect in the potential burglars.

The current study

The aim of the current study is to further investigate dynamic guardianship using a VR environment. Not only has the use of a virtual environment (VE) to collect data become increasingly popular in the past years, but it also allows for a clear assessment of the actions performed by a burglar lining up to a burglary (van Sintemaartensdijk et al., 2021). Even though, according to Hollis-Peel & Welsh (2014), collecting data through observation has worked out well in the past, not every behaviour can be measure through observation while remaining unobtrusive. Using a VE will create a feeling of being in a realistic environment for the participants and therefore guarantees the most realistic procedure that can be created under the given circumstances (Mania & Chalmers, 2001; Van Gelder et al., 2017).

The different level of dynamic guardianship used to deter burglars are self-switching lights, self-closing blinds, and a smart camera audio. The study will assess the scouting behaviour of a student sample of burglars by look at the distance walked, and time spent in the neighbourhood by each participant to measure deterrence. Additionally, the HEXACO personality model will be used to investigate possible links between its dimensions and dynamic guardianship level. Furthermore, to shed light on dynamic guardianship a scale was developed, aiming at exploring both the burglars' and residents' perspective towards dynamic guardianship. Therefore, this research will examine *To what extent does the use of dynamic guardianship, represented by using self-switching lights, self-closing blinds and a smart camera audio, influence the scouting behaviour in burglars?*

Method

Design and Participants

The study is a between-subject experiment with four experimental conditions: Self-switching lights, self-closing blinds, smart camera audio and no guardianship. In total, 128 participants took part in this study. The recruitment was carried out using University of Twente's internal website SONA and through snowballing. The inclusion criteria were to have sufficient English skills as well as being 18 years of age. After excluding three participants due to technical difficulties in the virtual environment, the final sample comprised 125 students following a higher education. Those were randomly assigned to one of the following three conditions: 'self-switching lights' ($N = 32$); 'self-closing blinds' ($N = 31$); 'smart camera audio' ($N = 31$); or a control condition without a dynamic guardian present ($N = 31$). The participants' mean age was 22.8 ($SD = 3.8$) and more women (57.6%, $N = 72$) than men (42.4%, $N = 53$) where involved. Further, people from 26 countries participated in this study, with the majority being from Germany (38.4%) or the Netherlands (30.4%). Participants who signed up over SONA were compensated with two credits.

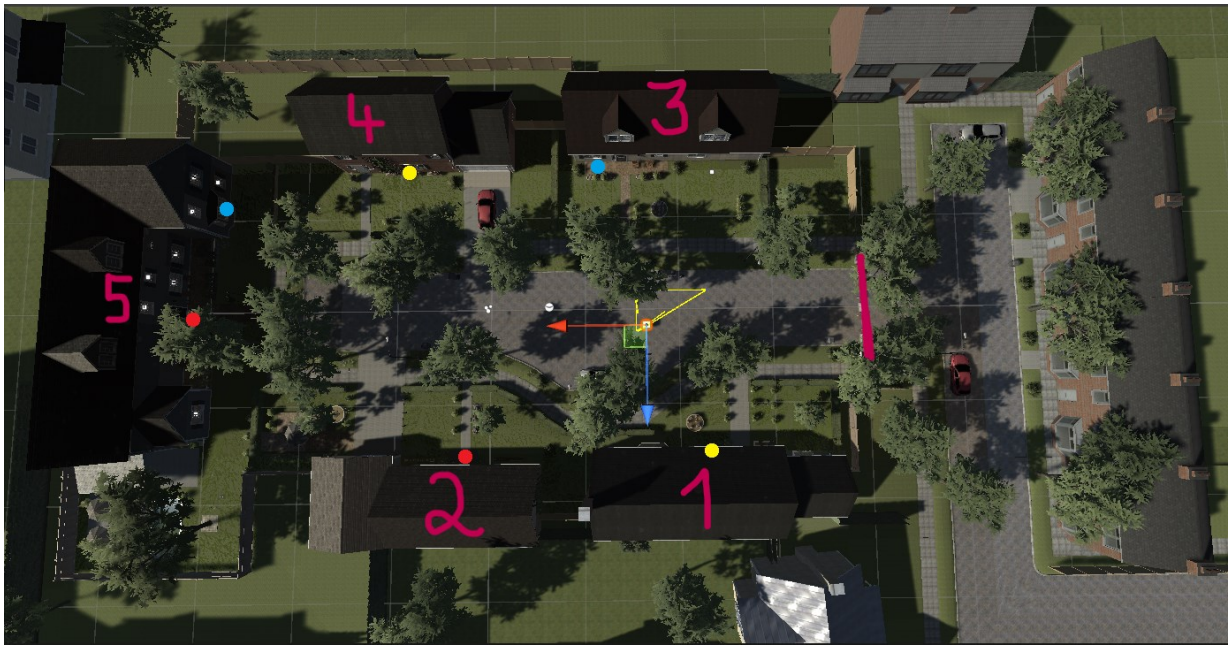
Materials

Virtual environment

The virtual neighbourhood was based on a preexisting neighbourhood scene and design alteration were made using Unity Pro Engine (2021.3.4f1). The existing environment was chosen as a basis as it comprised easily removable elements, such as white picket fences and US-American flags, which allowed for an easy transformation to a Dutch neighbourhood. Developmental changes were done with the help of free assets in the Unity store as well as creating items from scratch. Moreover, a preexisting car was rotated and programmed to drive out of the neighbourhood in the beginning of the scene to leave the impression of activity, in order for the neighbourhood to appeared less empty (van Sintemaartensdijk, 2022). Audio for the car, pool filter and nature were added to the scene. The final neighbourhood consisted of an endpoint street with five different looking houses (see Figure 1).

Figure 1

Bird perspective of the virtual neighbourhood indicating the houses alongside their respective (dynamic) guardians



Note. Blue rounds indicate the placement of self-switching lights; Yellow rounds indicate the placement of self-closing blinds; Red rounds indicate the placement of smart cameras.

Participants viewed the virtual neighbourhood using the Oculus Quest 2 VR head-mounted display with a stereoscopic view allowing to look around fully. Further, they used game controllers to navigate through the neighbourhood. Both controllers had a joystick with a different feature: The left one for walking around and the right one for switching one's perspective. Every participant started standing in the middle of the street facing the roadblock (see Figure 2). The roadblock kept participants in the required neighbourhood and was simultaneously used as an exit point for leaving the virtual environment.

Figure 2

Participants outlook of the start position on the neighbourhood

Manipulation

For each condition a dynamic guardian was placed in two of the five houses. For *self-switching lights* a preexisting lamp on the ground floor of House 3 and 5 was activated (see Figure 3). For *self-closing blinds* a black blind was placed behind a window on the ground floor of House 1 and 4 (see Figure 4). For the *smart camera audio* a camera including an audio (“Hey! I can see that you are looking for something. Can I help you?”) was placed outside of the front door of House 2 and 5 (see Figure 5). After activation a red light on the camera turned on. Each condition had its own trigger zone which included the property of the house as well as the pavement in front of it. Triggering happened when a participant stepped into the zone. It was only possible to trigger something once. For *no guardianship* the lights, blinds and cameras were disabled and therefore, could not get triggered.

Figure 3

Self-switching lights installed in House 3 after triggering.

Figure 4

Self-closing blinds installed at House 1 after triggering.

Figure 5

Ring camera installed on House 5 after triggering

Time Spent and Distance Walked. For each participant the virtual environment measured the time spent (in seconds) in the virtual environment and the distance walked (in meters). The data was provided in a log file. As a safety measure each participation was screen recorded using Open Broadcast Software (OBS 30.0.2).

Questionnaires

Participant experience. To get a better understanding of the participants experience in the virtual neighbourhood as well as their perception of what was exposed to them and their decision making, three items were asked. The first item was supposed to check if there were elements in the neighbourhood that influenced the participants experience, such as objects that unintentionally stood out ("What have you seen in the neighbourhood? Was something remarkable?"*)*. While only 20 participants reported having noticed one of the conditions; most people reported to have noticed cars being present on the property or close to one ($N = 26$), whereas the vast majority said to have been impacted by the presence of cameras outside of some homes ($N = 71$). The second and third items were supposed to check which house appeared most lucrative to the participants and why ("Which house would you most likely burgle?" Options: House 1-5; "Why did you choose that specific house to burgle?"). The former clearly indicated that House 2 was overall the least favourite house to burgle, whereas House 5 was the most favourite house to burgle due to its luxurious appearance, expect for when the camera audio was activated. See Appendix A, Table 1 for the frequency per

condition of choosing each house and Appendix B for a collection of all answers given by participants regarding their choices.

HEXACO-60. The 60-item HEXACO inventory, created by Ashton and Lee (2009), measures six personality constructs: Honest-Humility (α = .63), Emotionality (α = .76), Extraversion (α = .80), Agreeableness (α = .74), Conscientiousness (α = .76), and Openness to Experience (α = .77). Each construct is measured by 10 items on a 5-point Likert scale (1 = *strongly disagree*, 5 = *strongly agree*). Followingly for each personality construct a mean score was calculated to indicate its final score. A higher score indicated a stronger placement of a trait.

Dynamic Guardianship Scale. Since there was no preexisting questionnaire measuring Dynamic Guardianship from the burglars' perspective and the residents' attitude towards Smart Home Devices, a new scale comprising two constructs was created. Learning more about the residents' attitude towards SHD is crucial, because the scale is aiming at measuring Dynamic Guardianship which is represented by SHD. The first construct focused on the *burglars' perspective* and aimed at measuring if activity in the neighbourhood is noticed. The activity is represented by the dynamic guardians self-switching lights, self-closing blinds, and a smart camera audio, which the items of the scale are asking about. Further, it is exploring if those dynamic guardians influence the decision-making of potential burglars when choosing a target in the neighbourhood. The items created for this part of the scale were clustered under the following broader topics: *Perception of Neighbourhood Activity* (Items 1-9), *Burglars' Decision-Making Process* (Items 10-18), and *Factors Influencing Risk Perception* (Items 19-23) (see Appendix C, Table 2 for a list of all items including their respective references).

The second construct of the scale focused on the *residents' perspective* and aimed at measuring if participants attitude towards the devices representing dynamic guardianship in the environment is impacted by being exposed to them in the environment. To achieve that, participants were asked to take on the perspective of a resident who is considering acquiring one of those devices and asked about their general attitude towards SHD. In the context of this study the three dynamic guardians were addressed as Smart Home Devices (SHD). Not all SHD are dynamic guardians, but the ones used in this study are. It was described to participants as devices that can be installed at home and creates the illusion of someone being physically present when in reality nobody is home. The items created for this part of the scale were based on the different level of the Protection Motivation Theory (PMT): *Severity* (Items 1-3), *Vulnerability* (Items 4-6), *Intrinsic reward* (Items 7-9), *Extrinsic reward* (Items 10-12),

Response efficacy (Items 13-16), *Self-efficacy* (Items 17-18), *and Response Cost* (Items 19-20) (see Appendix C, Table 3 for a list of all items including their respective references). To assess this perspective, the PMT was used as it describes two ways of how individual respond to and manage triggers regarding potential threats (Rogers, 1975; Shillair, 2020). Both constructs were measured on a 5-point Likert scale (1 = Strongly disagree, 5 = Strongly agree).

Burglars' perspective. In order to investigate the factor structure of the burglars' perspective an exploratory factor analysis (EFA) was conducted. For that, items 7, 8, 10, and 22 were recoded due to their negative phrasing. A Kaiser-Meyer-Olkin measure of sampling adequacy revealed a mediocre sampling at 0.66. To find main factors that explain the factor structure with orthogonal rotation, a principal-axis factor extraction was conducted. The analysis resulted in 7 factors with Eigenvalues larger than 1 displayed in Table 1. Observed cross-loadings were assigned to the Factor with the highest correlation.

Table 1

Factors of the burglars' perspective scale and its relevant descriptives

	Items (sorted by strength of individual loading)	Eigenvalue	Explained variance	Factor loading range
Factor 1	2, 5, 4, 13, 1, and 3.	3.95	17.19%	65 to .78
Factor 2	12, 14, 11, and 9.	2.89	12.58%	.75 to .83
Factor 3	22, 21, and 10.	2.27	9.87%	.63 to .91
Factor 4	16 and 15.	2.00	8.71%	.87 to .88
Factor 5	19, 20, 23, and 8.	1.41	6.12%	-.45 to .81
Factor 6	7 and 6.	1.29	5.61%	.75 to .78
Factor 7	17 and 18.	1.06	4.60%	.74 to .75

Note. To see the contents of each item see Appendix C, Table 2.

Factor 1 (6 items; $M = 3.8$, $SD = 5.0$) represented the burglars perceived level of activity of the neighbourhood and was named "perceived activity level". Factor 2 (4 items; $M = 4.1$, $SD = 3.8$) represented different elements that deterred the burglar from the neighbourhood and was named "SHD". Factor 3 (3 items; $M = 3.3$, $SD = 2.8$) represented the burglars perceived challenge associated with a break-in and was named "neighbourhood security level". Factor 4 (2 items; $M = 2.9$, $SD = 1.8$) represented the perceived involvement of neighbourhood residents and was named "social cohesion". Factor 5 (4 items; $M = 3.8$, $SD = 1.9$) represented the likelihood of getting caught and was named "apprehension of

arrestment". Factor 6 (2 items; *M* = 3.9, *SD* = 2.1) represented the burglar's personal preference of selecting a house and was named "burgling attitude". Factor 7 (2 items; *M* = 3.5, *SD* = 1.6) represented the perception of how involved neighbours might get and was named "neighbourhood residents activity level".

Residents' perspective. In order to investigate the factor structure of the residents' perspective an exploratory factor analysis was conducted (EFA). For that, items 8-13, and 20 were recoded due to their negative phrasing. A Kaiser-Meyer-Olkin measure of sampling adequacy revealed middling sampling at 0.74. To find main factors that explain the factor structure with orthogonal rotation, a principal-axis factor extraction was conducted. The analysis resulted in 7 factors with Eigenvalues larger than 1 displayed in Table 2. Observed cross-loadings were assigned to the Factor with the highest correlation.

Table 2

Factors of the residents' perspective scale and its relevant descriptives

	Items (sorted by strength of individual loading)	Eigenvalue	Explained variance	Factor loading range
Factor 1	4, 3, 16, 7, and 15.	4.40	22.01%	.52 to .74
Factor 2	11, 12, 10, and 1.	1.78	8.89%	.48 to .85
Factor 3	5, 6, and 19.	1.71	8.53%	.55 to .80
Factor 4	14 and 8.	1.33	6.65%	.61 to .71
Factor 5	2 and 9.	1.26	6.29%	.61 to -.76
Factor 6	20 and 13.	1.04	5.20%	.75 to .78
Factor 7	18 and 17.	1.01	5.04%	.53 to .90

Note. To see the contents of each item see Appendix C, Table 3.

Factor 1 (5 items; *M* = 3.5, *SD* = 3.6) represented the attitude that SHDs have a direct impact on the likelihood of a break-in and was named "SHD impact". Factor 2 (4 items; *M* = 2.7, *SD* = 3.1) represented that not getting SHDs is freeing personal resources to use on other things and was named "freed resources". Factor 3 (3 items; *M* = 2.2, *SD* = 2.4) represented threats in one's social circle regarding break-ins and was named "perceived level of protection". Factor 4 (2 items; *M* = 2.1, *SD* = 1.5) represented one's perceived ability to be protected from a break-in and was named "ability to protect oneself". Factor 5 (2 items; *M* = 3.8, *SD* = 1.1) represented mental stress related to getting SHDs and was named "mental load". Factor 6 (2 items; *M* = 3.7, *SD* = 1.8) represented worries regarding one's own and others privacy after installing SHDs and was named "privacy concerns". Factor 7 (2 items; *M*

= 4.1, *SD* = 1.4) represented a person's confidents in acquiring SHDs and was named "ability to acquire SHDs".

Gaming experience. To control for a possible influence of participants preexisting Gaming Experience on their behaviour in the virtual neighbourhood, participants were asked to indicate their weekly gaming average in hours on the following devices: Games with a controller (*M* = 1.8, *SD* = 3.5), games with a keyboard (*M* = 4.0, *SD* = 6.6), and VR games with a head-mounted display (*M* = .1, *SD* = .5). The items were taken from research conducted by van Sintemaartensdijk et al. (2021).

Presence. To measure participants' feelings of spatial presence in the VE, the 7-item short Spatial Presence Experience Scale was used (Hartmann et al., 2016). The wording of the items was adjusted from "…the area of the presentation" to "…the virtual neighbourhood" to ensure participants would think about the virtual neighbourhood while answering. All items were measured on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree) (*M* = 3.4, *SD* = 0.7). The higher the mean score, the more immersed the participants felt in the VE. Further, reliability was acceptable (α = .75).

Cyber-sickness. To test possible discomfort experienced by participants due to the exposure to the VR, a selection of items from the Simulator Sickness Questionnaire were used (Kennedy et al., 1993) (*M* = 2.3, *SD* = 0.8). The 5-items (nauseous, stomach ache, dizziness, lack of focus and blurred vision) were measured on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree) (e.g., "The virtual environment made me nauseous"). Further, the reliability is slightly too low, since an alpha should be bigger than 0.7 (α = .66). The slightly too low score can be explained by the fact that cyber sickness translates differently to people. Only five items of the initial scale were used, meaning there is a chance that feelings of sickness were experienced but not covered by the selection of items.

Self-reported delinquency. To rule out potential delinquent people that have preexisting knowledge about burgling, participants were asked to rate performing certain kinds of behaviour on a self-reported delinquency scale (Svensson et al., 2013). All items were rated on a 5-point Likert scale (never, 1-2 times, 3-5 times, 6-10 times, more than 10 times). The first 21 items were considering the past two years, while the final two items considered the last 12 months (e.g., "How often in the last two years have you burgled a house to steal something?"). The reliability was acceptable (α = .75). The threshold was set to exclude participants who indicated for five or more items to have performed delinquent behaviour. Further, special focus was placed on items directly measuring burgling behaviour,

such as items 8-10. No participant crossed the chosen threshold leading to nobody being excluded.

Demographics. Lastly, participants were asked to provide the demographics gender, age, country of origin, and current level of education.

Procedure

The research project was granted ethical approval by the Ethics Committee of the department of Behavioural Management and Social Sciences at the University of Twente (approval code: 231189). Participants could then select and sign up for a timeslot via the recruitment system SONA. The research took place in the lab at the University of Twente in the Cubicus building. Following their arrival, participants were seated in front of a laptop to read the consent form. After giving consent, participants were introduced to the contents of the study and randomly assigned to one of the four manipulations (one of the three dynamic guardianship conditions or control condition). Next, the researcher provided a brief introduction to the Oculus and corresponding controllers. The participants had the opportunity to ask questions before entering the VR environment. While in the environment, the researcher answered possible questions and manually screen recorded what the participant was doing in the virtual neighbourhood in case the data needed clarification after collecting it. The participants moved around freely and were able to autonomously leave the virtual world by running through the roadblock. After leaving the virtual environment, the devices were handed back to the researcher. The participants continued by filling in the remaining questionnaires. In the end, each participant was fully debriefed about the real nature of the study and was given the opportunity to withdraw consent for participation (see Appendix D). Before the participants left the lab, they were reminded that contact information regarding questions about the participation or other concerns could be found on SONA and in the e-mail send after signing up for the study. Bachelor students of the University of Twente received two Test Subject credits for their participation. The study approximately took 45-60 minutes.

Results

Preliminary analysis

The statistical software IBM SPSS (Version: 29.0.1.0) was used to clean the data and run all of the analysis. R studio (Version: 2023.12.1+402) was used to calculate the overall distance walked and time spent in the neighbourhood from the logfiles provided by Unity. Table 1 displays the means and standard deviations for the four levels of Guardianship (self-switching lights, self-closing blinds, smart camera audio, and no guardianship) alongside all of them together. Moreover, Pearson’s correlation was computed for the burglars’ perspective,

the residents' perspective and the HEXACO separately with distance walked and time spent illustrated in Table 2.

Table 1

Means and Standard Deviations for the most important constructs

	Lights	Blinds	Camera	Control	All
Honest-Humility	3.5(0.6)	3.4(0.6)	3.5(0.5)	3.3(0.6)	3.4(0.6)
Emotionality	3.4(0.6)	3.3(0.7)	3.3(0.7)	3.1(0.6)	3.3(0.7)
Extraversion	3.3(0.7)	3.5(0.7)	3.5(0.5)	3.6(0.7)	3.5(0.7)
Agreeableness	3.2(0.7)	3.3(0.6)	3.3(0.6)	3.2(0.6)	3.2(0.6)
Conscientiousness	3.3(0.6)	3.6(0.6)	3.5(0.6)	3.5(0.7)	3.4(0.6)
Openness	3.7(0.7)	3.6(0.7)	3.8(0.7)	3.6(0.6)	3.7(0.7)
Burglars' perspective	3.6(0.4)	3.6(0.5)	3.7(0.4)	3.5(0.4)	3.6(0.4)
Residents' perspective	3.0(0.4)	3.3(0.4)	3.1(0.3)	3.0(0.5)	3.1(0.4)
Gaming Experience	2.8(3.5)	1.2(1.3)	1.9(2.4)	2.0(3.6)	2.0(2.9)
Spatial Presence	3.3(0.8)	3.7(0.6)	3.5(0.6)	3.3(0.7)	3.4(0.7)
Cyber-sickness	2.3(0.9)	2.4(0.8)	2.3(0.8)	2.0(0.9)	2.3(0.8)
Distance walked	463.8(215.4)	448.2(184.9)	399.7(179.4)	396.0(191.6)	427.2(193.4)
Time spent	5.4(2.2)	5.5(2.6)	5.1(2.0)	4.7(2.2)	5.2(2.3)

Note. Variables were measured using a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), except for distance walked (in meters) and time spent (in seconds).

Further, three individual general linear models were run to examine if Gaming experience, Spatial Presence, and Cyber-sickness differ between the Conditions (lights, blinds, camera, and control). No significant results were indicated by the analysis for Gaming experience ($F(3, 121) = 1.762$, $p = .158$, $\eta^2 = .042$), Spatial Presence ($F(3,121) = 2.565$, $p = .058$, $\eta^2 = .060$), and Cyber-sickness ($F(3,121)= 1.298$, $p = .278$, $\eta^2 = .031$). The findings can be an indication that there were no differences on these variables between the experimental groups, leading to the assumption that they are independent from the Conditions. Therefore, they do not need to be added as a covariate.

Table 2

Correlations between Distance walked and Time spent on burglar's perspective, resident's perspective and Personality

	Walked	Time	Bp	Rp	H	E	X	A	C	O
Distance walked										
Time spent	.87**									
Burglar's perspective	-.11	-.09								
Resident's perspective	.15	.15	.06							
H	-.16	-.13	-.01	-.05						
E	-.07	.05	.09	.09	-.08					
X	.05	-.01	-.02	.00	.07	-.27**				
A	-.01	-.05	.07	.01	.14	-.13	.07			
C	-.00	.01	-.14	.14	.18*	-.02	.12	.02		
O	.14	.16	.16	.02	.06	.02	.15	.08	-.12	

Note. * $p < 0.05$. ** $p < 0.01$. H = honest-humility, E = emotionality, X = extraversion, A = agreeableness, C = conscientiousness, O = openness to experience.

Main analysis

To be able to assess *"To what extent does the use of dynamic guardianship, represented by using a ring light, self-closing blinds and switching on lights, influence the scouting behaviour in burglars?"* a General Linear Model analysis was conducted, using distance walked and time spent in the neighbourhood as dependent variables. Further, two separate GLM were executed for possible effects of the conditions on burglars' perspective and residents' perspective.

Conditions on distance walked and time spent. A GLM was executed to find possible effects of the different conditions on distance walked and time spent of the participants in the virtual environment revealed no significant difference for either one (distance walked, $F(3, 121) = .980$, $p = .404$, $\eta^2 = .024$; time spent, $F(3, 121) = .816$, $p = .488$, $\eta^2 = .020$). Hence, no differences can be found for distance walked and time spent.

Conditions on the burglars' perspective. To assess if the conditions have an effect on participants perception of the neighbourhood and what stood out to them from a burglars' perspective, another GLM was run. The output indicated that there was a significant effect of the conditions on the whole burglars' perspective scale ($F(3, 121) = 1.27$, $p = .290$, $\eta^2 = .030$). For further clarification, a post-hoc analysis including a Bonferroni test was conducted $F(3, 121) = 1.27$, $p = .290$). It indicated that there is no effect between either of the conditions: lights and blinds ($p^{\text{Bonferroni}} = 1.000$), lights and camera ($p^{\text{Bonferroni}} = 1.000$), lights and control

($p^{\text{Bonferroni}} = .775$), blinds and camera ($p^{\text{Bonferroni}} = 1.000$), blinds and control ($p^{\text{Bonferroni}} = 1.000$), and camera and control ($p^{\text{Bonferroni}} = .442$).

To get a better understanding of what this result entails, another GLM was run for the conditions on each factor of the burglars' perspective scale. No significant effects were found of the conditions on Factors 2-7 (Factor 2, $F(3, 121) = 0.545$, $p = .653$, $\eta^2 = .013$; Factor 3, $F(3, 121) = 1.538$, $p = .208$, $\eta^2 = .037$; Factor 4, $F(3, 121) = 0.791$, $p = .501$, $\eta^2 = .019$; Factor 5, $F(3, 121) = 0.014$, $p = .998$, $\eta^2 = .000$; Factor 6, $F(3, 121) = 0.344$, $p = .794$, $\eta^2 = .008$; Factor 7, $F(3, 121) = 1.868$, $p = .139$, $\eta^2 = .044$). However, the conditions did show an effect on Factor 1 "perceived activity level" ($F(3,121) = 5.310$, $p = .002$, $\eta^2 = .116$). This can mean that the dynamic guardians led to participants being more aware of what kinds of activities were happening in the neighbourhood. For further clarification, a post-hoc analysis including a Bonferroni test was conducted $F(3, 121) = 5.310$, $p = .002$). It indicated that there is an effect between lights and blinds ($p^{\text{Bonferroni}} = .008$) and lights and control ($p^{\text{Bonferroni}} = .009$), but not between lights and camera ($p^{\text{Bonferroni}} = 1.000$), blinds and camera ($p^{\text{Bonferroni}} = .190$), blinds and control ($p^{\text{Bonferroni}} = 1.000$), and camera and control ($p^{\text{Bonferroni}} = .203$).

Conditions on residents' perspective. Lastly, a final GLM was executed to further examine if the conditions effected the participants' perception of SHDs after being exposed to them in the neighbourhood. The analysis showed a significant effect of the conditions on the whole residents' perspective scale ($F(3, 121) = 3.47$, $p = .018$, $\eta^2 = .079$). This can mean that the exposure to dynamic guardianship did have an effect on the participants attitude towards SHDs.

To get a better understanding of what this result entails, another GLM was run for the conditions on each factor of the residents' perspective scale. No significant effects were found of the conditions on Factor 1 ($F(3, 121) = 0.518$, $p = .670$, $\eta^2 = .013$) and Factors 3-7 (Factor 3, $F(3, 121) = 0.718$, $p = .543$, $\eta^2 = .018$; Factor 4, $F(3, 121) = 1.932$, $p = .128$, $\eta^2 = .046$; Factor 5, $F(3, 121) = 1.771$, $p = .156$, $\eta^2 = .042$; Factor 6, $F(3, 121) = 1.219$, $p = .306$, $\eta^2 = .029$; Factor 7, $F(3, 121) = 0.643$, $p = .589$, $\eta^2 = .016$). However, the conditions did show an effect on Factor 2 "freed resources" ($F(3,121)= 4.734$, $p = .004$, $\eta^2 = .105$). This can mean that the perception of an active SHD in the neighbourhood might have influenced the attitude of a resident later on. For further clarification, a post-hoc analysis including a Bonferroni test was conducted $F(3, 121) = 4.734$, $p = .004$). It indicated that there is an effect between lights and blinds ($p^{\text{Bonferroni}} = .021$) and blinds and control ($p^{\text{Bonferroni}} = .004$), but not between lights

and camera ($p^{\text{Bonferroni}} = 1.000$), lights and control ($p^{\text{Bonferroni}} = 1.000$), blinds and camera ($p^{\text{Bonferroni}} = .099$), and camera and control ($p^{\text{Bonferroni}} = 1.000$).

Discussion

Previous research has viewed guardianship as either being present or absent in a neighbourhood and most prominently shown as either a symbolic or physical guardian (Reynald, 2009; van Sintemaartensdijk et al., 2022; van Sintemaartensdijk et al., 2021). Symbolic guardianship describes the deterring effect of symbols such as CCTV cameras or neighbourhood watch signs that leave the impression that somebody could be around to watch (Hollis-Peel et al., 2011; van Sintemaartensdijk et al., 2022). Physical guardianship describes the physical presence of individuals, such as neighbourhood residents (Sintemaartensdijk et al., 2021). Since it is not feasible to have physical guardian available at all times and symbolic guardianship is not as effective in deterring potential burglars, the combination of both led to the idea behind dynamic guardianship. Dynamic guardianship describes a device that leaves the impression that somebody is home when in reality nobody is present. This study is the first to examine dynamic guardianship. It aimed at experimentally assessing the effects of dynamic guardianship on the scouting behaviour of burglars when looking for a burglary target. Dynamic guardianship was represented by self-switching lights, self-closing blinds and a smart camera audio. The burglars' scouting behaviour was measured by looking at the distance walked and time spent in the neighbourhood. Further, a dynamic guardianship scale was used to look at the burglars' perspective when looking for a lucrative house, and the residents' perspective regarding requiring SHDs.

It appeared that none of the guardians influenced distance walked and time spent of the burglars in the neighbourhood. When assessing the burglars' perspective during scouting, they placed most value on the activity level of the neighbourhood. Followingly, participants were asked to switch from the burglar perspective to a residents' perspective to indicate their attitude towards SHD. Being exposed to dynamic guardianship had an overall effect on the residents' attitude towards SHD, while being most concerned about their freed resources when thinking about acquiring them.

Dynamic guardianship on distance walked and time spent

The dynamic guardians (self-switching lights, self-closing blinds, and smart camera audio) present in the environment aimed at deterring potential burglars from targeting their respective house. None of the guardians had a deterring effect on the burglars' scouting behaviour. An explanation might be that a delay in the loading of the environment in Unity affected whether or not participants notice dynamic guardianship. When viewing the screen

recordings of the VR part of this study, it was indicated that during many sessions the scene was slow in adjusting to the participants turning their head when moving through the neighbourhood or after suddenly changing direction. It is possible that through the delay in scene loading, participants have missed the self-switching lights or self-closing blinds conditions and only noticed them once they were already activated. Previous research regarding the effects of visual delays when performing tasks in virtual reality underlines the impact it can have on the quality of the experience. Van Polanen et al. (2019) stated that participants of his study experienced tasks to perform in VR as more difficult if the command was performed with a delay. This matched research conducted by Brunnström et al. (2018), who additionally looked at the impact a lag of the visual scene had on the user's quality of experience in VR. His findings confirmed that a lag of the visual scene indeed decreases the quality of the VR experience.

Further, the results are contrary to findings stating that neighbourhood watch signs alongside police signs managed to deter burglars and impact the distance travelled and time spent of the sample (van Sintemaartensdijk et al., 2022). Admittedly, the study only used symbolic guardians, which limits the extent to which those findings can be compared to the findings of this study. Moreover, it is important to emphasize that those research findings were based on a sample of real burglars, whereas the sample of this study contained a mock sample of student burglars. It is therefore questionable whether the dynamic guardians were perceived at all. According to recent study findings, it is common to find differences in scouting behaviour and the perception of guardians when comparing burglar and non-burglar sample (van Sintemaartensdijk et al, 2021; van Sintemaartensdijk et al., 2022). Hence, it might be that studies with a burglar sample might have led to different findings because burglars might be more attuned to noticing guardians that decrease the attractiveness of a potential target.

Subsequently, an explanation why specifically the smart camera audio had no deterring effect on burglars might be due to the cameras not covering the entirety of the virtual environment. Cameras were only present above the front door of two of the houses in the neighbourhood, leaving three of them uncovered. According to van Sintemaartensdijk et al., (2022) the more time burglars spends in the neighbourhood, the higher the likeliness of getting caught. This can lead to the assumption that the camera audio perhaps did have an effect on the participants, but only deterring them from the houses that displayed smart cameras and not from neighbouring houses. Participants might have left the area of the neighbourhood that was covered by cameras and decided to explore other, presumably safer,

areas (Nilsson et al., 2017). Hence, decreasing the time spent near properties with a camera, but increasing time spent near properties considered as safer. This assumption is substantiated by findings from Langton and Steenbeek (2017) stating that burglars prefer targets that are seemingly easier to escape from. It might be that burglars in this study perceived areas not covered by cameras as the safer option and easier to escape from and were therefore not deterred from the whole neighbourhood by the presence of cameras with a voice recording. This possibly resulted in a shift of distribution of where the time was spent but not how much.

Dynamic guardianship on the burglars' perspective

The burglars' perspective on planning a burglary provided the insight that they focus most prominently on perceived activity level of the neighbourhood. This shows once again the importance of physical guardianship when attempting to deter burglars, even when the sample only contains non-burglars (van Sintemaartensdijk et al., 2021; Hollis et al., 2013). Further, the burglars' decision-making regarding the lucrativeness of the houses in the neighbourhood might be most prominently impacted due to the fact that the setting was created in a daytime neighbourhood scene. After the regulations enforced because of COVID-19 were lifted and it was safe to return to the office, 75% of the Dutch working population had returned leaving their homes unoccupied during the day (Séveno, 2022). This has likely influenced burglars to shift their targeting behaviour back to how it was before the pandemic, namely targeting homes more often during the day.

Past research indicates that burglars target houses based on different decisions during the day in comparison to during the night (Coupe & Blake, 2006, Montoya et al., 2014). It might be that the unique combination of people being able to leave their house again after having to spend a longer period of time in them and the different approach of burgling during the day explain the sole focus on the neighbourhood's activity level when looking for target houses. It is possible that other elements are not perceived as a threat anymore in comparison to encountering an actual person. However, it is crucial to keep in mind that this studies sample did not comprise of actual burglars, but mock-up student burglars, which commonly lead to differences in findings (van Sintemaartensdijk et al, 2021; van Sintemaartensdijk et al., 2022).

Dynamic guardianship on the residents' perspective

Moving towards the residents' perspective part of the scale, the results imply that the exposure to the dynamic guardians has an effect on the residents' attitude towards SHD. However, since no pre-test measurement was included in this study, we cannot be sure what the effect is exactly. It might be possible that purely raising awareness about their existence is

not enough, especially when we cannot be sure about whether or not participants have actually noticed SHD in the environment in the first place. Therefore, looking at the different factors that make up the scale provided more insights.

The single factor results imply that people would only acquire SHD if it does not interfere too much with their resources, such as free time and money. The Protection Motivation Theory (PMT) might be able to provide more insights regarding the non-significant findings of the separate Factors of this scale as it was also used as theoretical background to formulate this scale's items on (see Appendix C, Table 2 for a complete list of items). The PMT reports two ways of how individuals respond to and manage triggers regarding potential threats (Rogers, 1975; Shillair, 2020). When faced with a trigger that has an incorporated fear appeal message, individuals are prompted to adopt protective measures to avoid activities that are potentially harmful. In order to process the fear appeal message, they follow a two-channel procedure involving a threat appraisal and coping appraisal. If the threat appraisal outweighs the coping appraisal, then individuals are more likely to display maladaptive responses, such as denial, ignoring or minimizing the thread. On the contrary, if the coping appraisal outweighs the threat appraisal individuals are more motivated to engage in adaptive actions against the perceived threat, meaning protection motivation has been achieved.

The pathways explained by the PMT indicate that it seems likely that (either) the SHD in relation to burglary selected for this study were not perceived as harmful by the participants and therefore no potential threat appeal was trigger in the participants. That would further explain why participants valued their free resources over acquiring SHDs to provide further protection again possible burglaries. On the contrary, it is possible that a threat appeal message was triggered, but instead of engaging in healthy coping mechanisms, the threat appraisal outweighed healthy coping, leading to perform coping behaviour. It is likely that due to the concept of dynamic guardianship alongside the SHD being new and relatively unexplored might make it appear alienated to the participants (Trautmann et al, 2008). The mere exposure effect possibly can explain how this can be shifted in the future. It describes how the repeated exposure to a situation or device increases the level of familiarity which increases the level of ones liking toward the exposed thing (Montoya et al., 2017; Hansen et al., 2009). Therefore, it might be possible that repeated exposure to dynamic guardianship devices the attitude of people will change toward them.

Strengths and limitations

An important strength of this study is the use of virtual reality (VR) to assess the behaviour and decision-making of burglars. VR is especially helpful when looking at the behaviour lining up to a burglary (van Sintemaartensdijk et al., 2021). Even though a VR neighbourhood is far from being equal to a real-life neighbourhood, it was designed to be as close to resemble a real-life neighbourhood as possible. Moreover, it allows to observe behaviour that is not feasible to unobtrusively observe in real-life (Meenaghan et al., 2018).

Furthermore, this study made a first attempt in developing a scale to measure dynamic guardianship by looking into participants experience with Smart Home Devices (SHDs: self-switching lights, self-closing blinds, smart camera audio). The scale further aimed at measuring not only the burglars' exposure to SHDs, but linking said exposure to assessing the burglars' focus while scouting (with the goal of selecting a burglary target). The findings are of great help to get an understanding about what needs to be aimed at intervention wise to deter more burglars in the future. Additionally, it attempted measuring people's overall attitude towards SHDs alongside their willingness to invest in them after being exposed to how they function. Thereby, providing insights into what people consider important and unimportant regarding acquiring SHDs in the context of dynamic guardianship. Those insights are a fundamental key element for distributing devices to the population in order to reduce the burglary rate.

Some limitations need to be addressed. Working with virtual reality has its downsides as well. To provide a neighbourhood that appears as realistic as possible and immerses the participants, multiple elements were present that might have impacted the participants' overall experience. Amongst those things were active sprinklers on two of the properties and the camera being present in every condition. When looking at a real-life neighbourhood, then naturally sprinklers would be active, and a camera would be displayed to everybody who is walking around. However, in the context of this study it might have interfered with the experience of the participants. Another difficulty was the possible interference of the slow loading of the scene with the self-switching lights and possibly self-closing blinds condition. There is a possibility that participants did not see these dynamic guardians just because of a technical delay and were therefore not deterred by it.

Furthermore, this being the first time developing a scale aiming at measuring dynamic guardianship is another limitation of this study. While conducting the study it became clear that the inclusion of some of the items as well as the formulation of others were confusing to participants. Participants consistently asked for clarification about a couple of items while filling in the questionnaires about the burglars' perspective. Most prominently were items 15-

18, which were taken over from a preexisting scale by van Sintemaartensdijk et al. (2021). They aimed at getting an understanding of the possible involvement of neighbours. It appeared that since neighbours were not present in any of the conditions, participants were unsure about how to treat those items, which was indicated by asking the researcher for clarification while filling in the questionnaire ("Should I just imagine neighbourhood residents were present when answering the questions?"). Further, item 12 needs to be modified due to its double negative formulation ("I will spend less time acquiring an SHD by not installing one.").

Future research

Since the dynamic guardians used in this study did not have an impact on the scouting behaviour of burglars, it makes sense to adjust some elements of the research design for future research. One way of tackling this is by changing the setting in which the scouting takes place. Instead of letting participants scout the neighbourhood during the day, it can be adjusted to night-time. According to Coupe and Blake (2006) burglars perceive threats to be different during the night in comparison to burgling during the day. This is supported and further refined by Montoya et al. (2014), stating that burglars put more emphasis on target hardening factors and access control when looking for targets at night. Target hardening factors describe physical elements that increase the difficulty of a break-in, such as lights or alarms (Cozens et al., 2005). Access control describes that houses which are well-connected to roads and located in busier areas are more prone to be targeted for burglaries. This is further supported by findings stating that targeted houses at night are commonly accessed from a back door and therefore not easily noticeable from the street (Brantingham & Brantingham, 1984). Hence, when taking both target hardening and access control into consideration, it makes sense to change the position of the dynamic guardians of this study to covering specifically back entrances of houses. Further, dynamic guardians should not only be installed to be visible from the street but equally distributed in case observations of the house take place for instance from the garden. Moreover, the burglars' perspective part of the dynamic guardianship scale contained a couple of items asking about target hardening elements, but did not show a significant effect in this study. Since Montoya et al. (2014) are stressing the importance of target hardening elements when assessing burglary at night, it is possible that conducting the same research in a nighttime setting, might lead to different results.

Another approach to modifying the study design is by adjusting the current dynamic guardians. This can be achieved by moving both the self-switching lights and self-closing

blinds to the first floor of their designated houses. Instead of installing one of each, two could be installed using a trigger with a time difference. This leaves the impression that someone is first closing one blind/ is switching on one light and is then moving to the second one. By that it appears more realistic that somebody is home, in case a burglar is bold enough to walk directly up to the window but cannot spot anybody on the ground floor (Wright & Decker, 1996; Bennett, 2014). Is something then activated on the first floor the illusion of somebody being home when in reality nobody is there is still intact.

Conclusion

Dynamic guardianship is still a fairly under researched topic in the context of burglary and crime. Therefore, this study aimed at making a first attempt at peeling one of its many layers. The presence of self-switching lights, self-closing blinds and a camera audio had no effect on the scouting behaviour, distance walked and time spent, of the participants. Burglars focused mostly on the perceived activity level of a neighbourhood when scouting for a suitable target. Residents focused most on their freed resources when thinking about acquiring Smart Home Devices. Even though the selected guardians did not show significance, this does not mean they should be discarded already. By developing a scale that is aiming at measuring dynamic guardianship alongside testing three guardians in a virtual neighbourhood we get one step closer towards a better understanding of dynamic guardianship, while adding valuable information toward making Dutch neighbourhoods safer.

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Appendices

Appendix A

Table 1

Frequency per condition (lights, blinds, camera and control) of choosing each house by participants

	House 1	House 2	House 3	House 4	House 5	Total
Lights	3	1	12	2	14	32
Blinds	8	1	7	5	10	31
Camera	9	1	10	5	6	31
Control	12	1	4	6	8	31
Total	32	4	33	18	38	125

Appendix B

- House 1
  - Codes: no camera/ blind spot (27), easy exit (11), easy access (8), looked like they have valuable belonging inside (7), no obvious movement (5)
- House 2
  - Codes: no indication of present residents/ most unguarded (3), easy access (1)
- House 3
  - Codes: no cameras (28), empty looking (20), easy access (10), valuable item(s)/luxurious interior (9), easy escape (8), tree coverage/hidden (5)
- House 4
  - Codes: no camera (12), most obscure place (8), well off enough (7), little security measures (2)
- House 5
  - Codes: luxurious (33), easy access (17), fence for cover on property (12), camera only at front door (6), appeared empty (3)

Appendix C

Table 2

Dynamic Guardianship Scale Construct 1 Items including references (burglars' perspective)

Item	Reference(s)
Perception of Neighbourhood Activity:	
(1) I paid attention to the overall activity level when selecting a target residence.	Vandeviver and Bernasco (2019)
(2) My choice of a target residence was affected by the observed activity in the virtual neighbourhood.	Vandeviver and Bernasco (2019) "burglars prefer reducing the risk of detection" Montoya et al. (2014) "Occupancy: Most burglars prefer unoccupied targets. Occupancy cues include the presence of visible residents or indications that someone is at home (e.g., noises, lights, vehicles)" p.517
(3) The visible activity in the virtual neighbourhood decreased the attractiveness of a potential target.	Vandeviver and Bernasco (2019) Montoya et al. (2014) "Occupancy: Most burglars prefer unoccupied targets. Occupancy cues include the presence of visible residents or indications that someone is at home (e.g., noises, lights, vehicles)" p. 517 → prefer unoccupied → detection activity → less desirable
(4) The visible activity around a potential target decreased its attractiveness.	Kuhns (2012) Nee (2015) "While the goods were already identified, other cues (such as occupancy, access to the property and security features) rendering the property more or less easy to enter were used to decide when to actually undertake the Burglary." p. 55 Montoya et al. (2014) "Occupancy: Most

	burglars prefer unoccupied targets. Occupancy cues include the presence of visible residents or indications that someone is at home (e.g., noises, lights, vehicles)" p.517 → prefer unoccupied → less desirable
(5) My confidence in getting caught was influenced by the perceived level of activity.	Vandeviver and Bernasco (2019)
(6) I would have burglarized places that appeared empty.	Vandeviver and Bernasco (2019) "Absence of residents is a major predictor for burglary victimization" Kuhns (2012) Question 51: Would you rather burglarize places that are empty or that have people in them? Montoya et al. (2014) "Occupancy: Most burglars prefer unoccupied targets. Occupancy cues include the presence of visible residents or indications that someone is at home (e.g., noises, lights, vehicles)" p. 517 Snook et al. (2011) "76% of their burglars preferred the residence to be unoccupied" Van Sintemaartensdijk et al. (2021) "and hence reduced home occupancy, has been linked to increases in burglary rates" p. 658 → occupied houses are less favourable Van Sintemaartensdijk et al. (2022) "Households that have a higher rate of occupants being at home have a lower chance of being burgled" p. 13, 44
(7) I would have burglarize places that appeared occupied.	Kuhns (2012) Question 51: Would you rather burglarize places that are empty or that have people in them?

	Rengert (2015) “In Canada, a burglary is four times more likely to take place when the victims are home; in Britain, 59 percent of attempted burglaries involved occupied homes” p. 23 Catalano (2010) “In about 28% of these burglaries, a household member was present during the burglary” p. 1
(8) I would have targeted a house without visible activity.	Kuhns (2012) Question 21: Which type of place do you prefer to burglarize (please check choose your favourite target)? Montoya et al. (2014) “Occupancy: Most burglars prefer unoccupied targets. Occupancy cues include the presence of visible residents or indications that someone is at home (e.g., noises, lights, vehicles)” p. 517 Vandeviver and Bernasco (2019) “burglars prefer reducing the risk of detection”
(9) I would not have targeted a house equipped with Smart Home Devices such as cameras or automatic lights.	Kuhns (2012) Question 32: If you decide to burglarize a place and then learn that there is an alarm in the building, will you.. Van Sintemaartensdijk et al. (2022) “mere possibility implies that any criminal activity in the field of view of the camera runs the risk of being observed” → they want to reduce risk of detection Vandeviver and Bernasco (2019) → SHD might influence Van Sintemaartensdijk et al. (2022) “objects such as cameras or alarms have been included in the definition of guardianship” p. 13
Burglar's Decision-Making Process:	

(10) I think the neighbourhood was vulnerable to possible break-ins.	van Sintemaartensdijk et al. (2021) (Deterrence Scale) Original: “This neighbourhood is attractive to burgle”
(11) When deciding whether to burgle a place, I consider cues related to possible target-hardening devices (such as cameras).	Kuhns (2012) Question 24: “What types of things do you think about when deciding whether to burglarize a place“ Langton and Steenbeek (2017) “Once an area has been selected, a burglar is imagined to consider an array of alternatives, and is presumed to rationally appraise them, assessing the cost and benefits of each in order to inform the final decision” p. 2 Nee (2015) “While the goods were already identified, other cues (such as occupancy, access to the property and security features) rendering the property more or less easy to enter were used to decide when to actually undertake the Burglary.” p. 55
(12) I avoided residences with target-hardening devices (such as cameras).	Kuhns (2012) Question 30: Do alarms in buildings make a difference when choosing a target?; Question 32: If you decide to burglarize a place and then learn that there is an alarm in the building, will you:... Vandeviver and Bernasco (2019) “burglars avoid residences with access-restricting features such as fences and other target hardening devices” Van Sintemaartensdijk et al. (2022) “mere possibility implies that any criminal activity in the field of view of the camera runs the risk of being observed” → they want to reduce risk of detection Vandeviver and Bernasco (2019) → SHD

	might influence Van Sintemaartensdijk et al. (2022) "objects such as cameras or alarms have been included in the definition of guardianship" p. 13
(13) The discovery of an ongoing activity at a targeted location impacted my decision to carry out a burglary.	Kuhns (2012) Question 32: If you decide to burglarize a place and then learn that there is an alarm in the building, will you… Montoya et al. (2014) "Occupancy: Most burglars prefer unoccupied targets. Occupancy cues include the presence of visible residents or indications that someone is at home (e.g., noises, lights, vehicles)" p. 517
(14) Certain factors such as SHDs (such as ring cameras, self-switching lights, self-closing blinds) cause me not to burglarize a particular place.	Kuhns (2012) Question 25: "Do any of the following cause you not to burglarize a particular place (please check all that apply):" Nee (2015) "While the goods were already identified, other cues (such as occupancy, access to the property and security features) rendering the property more or less easy to enter were used to decide when to actually undertake the Burglary." p. 55
(15) Neighbourhood residents appeared to know each other well.	Van Sintemaartensdijk et al. (2021) → Deterrence scale
(16) Neighbourhood residents appeared to look out for each other.	Van Sintemaartensdijk et al. (2021) → Deterrence scale
(17) Neighbourhood residents would call the police when they saw a burglary taking place.	Van Sintemaartensdijk et al. (2021) → Deterrence scale
(18) Neighbourhood residents would intervene when they saw a burglary taking place.	Van Sintemaartensdijk et al. (2021) → Deterrence scale

Factors Influencing Risk Perception:	
(19) I assessed how likely I was to get caught while planning a burglary.	Kuhns (2012) Question 36: When planning a burglary, do you think about how likely you are to get caught? Vandeviver and Bernasco (2019) "burglars prefer reducing the risk of detection" Snook et al. (2011) "Rational choice theorists have proposed that criminals are fully rational decision makers who attach values to the possible rewards and the costs associated with an action, calculate the probabilities of these rewards and costs, weigh the values of rewards and costs by their respective probabilities, and choose the course of action that maximizes gains and minimizes losses" p. 317 Vandeviver et al. (2015) "Burglars have repeatedly expressed their dislike for houses that have an increased chance of detection by neighbors such as terraced houses and prefer targets that offer multiple escape routes in case of detection" p. 26
(20) I was less likely to commit a burglary if there is a good chance of getting caught during or after the burglary.	Kuhns (2012) Question 37: If you feel that there is a good chance of getting caught during or after the burglary, are you less likely to commit the burglary? Vandeviver and Bernasco (2019) "burglars prefer reducing the risk of detection"
(21) If I burgled this neighbourhood, I am likely to get caught.	Van Sintemaartensdijk et al. (2021) Deterrence scale; Original: "If you burgle in this neighbourhood, the chances of getting caught are small"

(22) I think this neighbourhood would have been an easy target.	Van Sintemaartensdijk et al. (2021) Deterrence scale; Original: "This neighbourhood appears difficult to burgle"
(23) I considered the likelihood of getting caught while committing a burglary.	Kuhns (2012) Question 37: Do you think about the likelihood of getting caught while you are committing the burglary?

Table 3

Dynamic Guardianship Scale Construct 2 Items including references (residents' perspective)

Item	References
Severity → perceived negative effects from burglaries	
1. Not using SHD is a serious threat to my safety.	Steven and Stephen (2020) inspired by: Question 1: Pertussis is a serious threat to my health.
2. A burglary can cause severe mental health issues (for the homeowner).	CBS (2023) based on a country wide survey: Reports from citizens in the Netherlands stated that burglaries negatively impact people's mental well-being.
3. The longer you wait to install an SHD, the greater the likelihood of a burglary.	MacDonell (2013) inspired by: Question 1: The earlier a person starts smoking, the greater the harm.
Vulnerability → perceived likelihood of becoming a victim of burglary	
4. If I do not install an SHD my home is at a higher risk of getting burgled while I am away.	Steven and Stephen (2020) inspired by: Question 4: I will get infected if I have contact with a patient who has pertussis.
5. Whenever I'm out and about I will worry about a possible burglary at home.	Swaray (2006) based on these findings: Paper shows a strong interdependence between households worry about burglary and actual and perceived probabilities of burglary → worry is said to be actually based on an increase in burglary rates (tested in England and Wales)
6. I will have to carry part of the responsibility of a burglary, if no SHD was installed.	Steven and Stephen (2020) inspired by: Question 6: I will get serious complications from pertussis if I'm not treated.

Intrinsic reward → perceived physical and psychological benefits from not installing SHDs	
7. I can protect my own resources, such as free time and energy, by installing SHDs.	Steven and Stephen (2020) inspired by: 7. I will boost my immune system if I acquire pertussis.
8. I can still protect myself from a burglary even if I do not install SHDs.	Steven and Stephen (2020) inspired by: Question 8: I can avoid the side effects of vaccination if I don't take the pertussis vaccination.
9. It is more convenient to rely on other preventative measures of burglary than SHDs.	Steven and Stephen (2020) inspired by: Question 9: It is more convenient to take antibiotics to prevent pertussis infection.
Extrinsic reward → perceived social benefits from not installing SHDs	
10. It will save me money if I do not install a SHD.	Steven and Stephen (2020) inspired by: Question 10: It will save me money if I don't take the pertussis vaccination.
11. I can avoid the hassles of installing an SHD.	Steven and Stephen (2020) inspired by: Question 11: I can avoid the hassles related to going for a pertussis vaccination (e.g. finding parking, queuing up and etc).
12. I will spend less time acquiring an SHD by not installing one.	Steven and Stephen (2020) inspired by: Question 12: The cost involved in the vaccination process can be reduced if I don't take the pertussis vaccine (for example save on usage of the syringe, vials, cotton an, etc.).
Response efficacy → perceived effectiveness after installing SHDs	
18. I will be less concerned about the security of my privacy if I am not installing an SHD.	Steven and Stephen (2020) inspired by: Question 18: I will take the pertussis vaccination despite the possibility of the side effect of vaccination.

13. I will not become a victim of burglary if I install an SHD.	Steven and Stephen (2020) inspired by: Question 13: I will not be infected by pertussis if I take the vaccine.
14. The surrounding neighbourhood will be safer after I installed an SHD.	Van Sintemaartensdijk et al. (2021), Van Sintemaartensdijk et al. (2022) based on: Research about the deterring effects of real presence in a neighbourhood, which is likely to have a similar effect when only an impression of presence as stated by dynamic guardianship is present Van Sintemaartensdijk et al. (2022) "objects such as cameras or alarms have been included in the definition of guardianship" p. 13 → supports assumption mentioned above: said objects can have an effect on guardianship/burglary, which then is likely to have an effect on the neighbourhood
15. The attractiveness of my home to a burglar will decline if I install an SHD.	Steven and Stephen (2020) inspired by: Question 15: The incidence rate of pertussis will reduce if I take the Pertussis vaccination.
Self-efficacy → personal beliefs in one's own ability to adopt behaviours against burglaries	
16. I will be able to find a suitable SHD to install at home.	Steven and Stephen (2020) inspired by: Question 16: I will take the pertussis vaccine even if my colleagues persuade me not to take it.
17. I can install an SHD if necessary.	Steven and Stephen (2020) inspired by: Question 17: I will take the pertussis vaccine regardless of its cost.
Response cost → perceived costs incurred after installing SHDs	

19. My friends will not believe that I am protected against burglaries if I do not use SHDs.	Steven and Stephen (2020) inspired by: Question 19: My colleagues will not believe that I am protected against pertussis if I take the vaccination.
20. Those who live with me or around me will not appreciate it if I install SHDs.	Steven and Stephen (2020) inspired by: Question 21: My family members will scold me if I take the pertussis vaccination.

Appendix D

Introduction and consent form of the questionnaire

Dear participant,

Thank you for choosing to participate in my study!

The study aims at looking into how lucrative houses in a Dutch neighbourhood appear to possible burglars. For that, a virtual environment will be used. The study has been reviewed and approved by the BMS Ethics Committee.

Your participation in this study is voluntary and withdrawing from it is possible at any point in time during or after the study without needing to give reason. Concerning your privacy, 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 and will be deleted afterwards. In case of a withdrawal, your data will be deleted immediately. If you have signed up over SONA you will still receive 2 points for participation.

In case of any further questions and/or comments about the study, please contact either the researcher (s.frerichs@student.utwente.nl) or the corresponding supervisor Dr. Iris van Sintemaartensdijk (i.vansintemaartensdijk@utwente.nl). For questions regarding ethical concerns or your rights as a participant, please contact the Ethics Committee/domain Humanities & Social Sciences of the University of Twente (ethicscommittee-bms@utwente.nl).

By continuing to the next page you confirm to have read and give consent to the information provided above.

Debriefing of the questionnaire

Thank you for participating in my study.

In the beginning, I told you that you are supposed to scout the neighbourhood as if you were a burglar looking for a lucrative house to burgle. For the purpose of this study, I 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 seeing 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.

Further, I mislead you by telling you to be cautious about getting caught by someone in the neighbourhood. I said this to make the experience as realistic as possible, however, it was not possible to get caught.

Please do not share those contents with other students to allow them an unbiased view in case of participation.

Do you have any other question? If you now feel like you would rather withdraw your consent of participation and usage of your data you can says so now.