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The Relation Between Residential Property and Its Surroundings and Day- and Night-Time Residential Burglary

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Abstract

This article examines how residential property and its surroundings influence day- and night-time residential burglary. Crime Prevention Through Environmental Design (CPTED) principles of territoriality, surveillance, access control, target hardening, image maintenance, and activity support underpin the study. Data were collected by observing 851 houses in the city of Enschede, half of which were burgled and half representing a random selection of houses not burgled. Multilevel multinomial regression models were estimated for predicting day- and night-time burglaries. The findings show that territoriality and access control predict daytime burglary while access control and target hardening predict night-time burglary. The analysis controls for offender availability, target attractiveness, and residential stability. The conclusion is that two separate burglary prevention frameworks are needed: one for day-and another one for night-time burglary.

Keywords

Crime Prevention Through Environmental Design (CPTED), environmental criminology, urban and neighborhood design

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Introduction

The rational choice model (Clarke & Cornish, 2010), the routine activities approach (L. E. Cohen & Felson, 1979), and the awareness space concept of the crime pattern theory (Brantingham & Brantingham, 2008) argue that crime can be explained by environmental rather than by offender characteristics (Tilley & Laycock, 2007; Wortley & Mazzerole, 2008). It is plausible that neither of these factors is solely responsible for crime but that both factors are responsible to some degree.

Research on property crime has focused on how offenders choose targets and carry out offenses. Rational choice theory assumes that offenders pursue normal goals like non-offenders do: They evaluate possible actions and choose the action that maximizes gain and minimizes costs and risks (Clarke & Cornish, 2010). The concept of limited rationality, however, proposes that for behavior to be rational, it does not have to be carefully preconceived and planned or require hierarchical, sequential decision making. It is enough that decisions are perceived to be optimal (Cromwell & Olson, 2006). According to the routine activities approach, "rational" choice is carried out during everyday-life routine activities such as on the way to shopping, entertainment, work, and school. Because some activities take place mainly during the day while others mainly during the night, the benefits and risks of burglary might vary by time and location. Offenders attempt to make rational decisions which could shape the urban burglary patterns differently by day or by night. The present study focuses on the physical environment and its relation with day- and night-time burglary. More specifically, we investigate whether burgled houses and non-burgled houses differ with respect to the CPTED concepts and whether day and night effects exist.

Burglary is mostly opportunistic and often takes place at an opportune moment when occupants are clearly absent and the house is perceived as vulnerable (Cromwell & Olson, 2006). A motivated offender must first identify a vulnerable target and then enter the property without being detected. A burglar's decision to "hit" a specific target is based on environmental cues that are perceived to have immediate consequences.

There is a considerable amount of research on residential burglary (Comeau & Klofas, 2014; Cozens, 2002; Cozens, Hillier, & Prescott, 2001; Cozens, Saville, & Hillier, 2005). The driving factors of burglary have been described in many studies (Bernasco & Luykx, 2003; Bernasco & Nieuwbeerta, 2005; Comeau & Klofas, 2014; Cozens et al., 2001; Cromwell & Olson, 2004, 2006; Hakim, Rengert, & Shachmurove, 2001; Nee & Meenaghan, 2006; A. Piquero & Rengert, 1999; N. L. Piquero, Cohen, & Piquero, 2010; Ratcliffe, 2003; Snook, 2004; Wright & Decker, 1994).

Burglars are usually driven by money because it affords them a luxury lifestyle, the so-called "Life as a party" described by Wright and Decker (1994). Besides economic motives, there are also social ones such as peer approval, status, and idiosyncratic motives, such as revenge, kicks, thrills, pathological behavior, and rebellion (Cromwell & Olson, 2006).

In addition to burglars' motives, research has also investigated target selection and the process of estimating target suitability. Four main categories have been identified:

a. *Familiarity*: Most offenders do not travel very far to offend since familiarity with surroundings reduces stress (Block & Bernasco, 2009; Rengert, Piquero, & Jones, 1999).
b. *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). Visibility and occupancy are somewhat passive concepts and therefore some prefer the concept of guardianship (Reynald & Elffers, 2009). Occupancy proxies such as a dog or a car in the driveway can deter a burglar (Weisel, 2002; Wright & Decker, 1994).
c. *Potential rewards*: The main driving factor of burglary is money. Signs of potential financial rewards in the dwelling play a role in target selection (Macintyre, 2001).
d. *The built environment*: Within the environment, the built environment has a prominent place. Crime Prevention Through Environmental Design (CPTED) concepts represent an operationalization of environmental models of crime. The CPTED approach states that the proper design and effective use of the built environment can lead to a reduction in the fear and incidence of crime, and an improvement in the quality of life (Cozens et al., 2005; Gibson, 2013).

The origins of CPTED can be traced mainly to the 60s and 70s (Angel, 1968; Jacobs, 1961; Jeffery, 1971; Newman, 1972; Robinson, 2013). Research findings on the built environment may be applicable to many types of crime but have until now focused on burglary, although they have also been applied to robberies (Casteel & Peek-Asa, 2000) and to injury control (Peek-Asa & Zwerling, 2003). The CPTED concepts are widely used by governments as guidelines for "designing out crime." In the Netherlands, for example, these concepts can be identified in the Police Marque Secured Housing, a certification scheme for new and old houses that can be requested for individual houses, apartment complexes and the neighborhood as a whole. The certification includes issues such as locks and door standards, type of

building materials to prevent fire and deter vandalism, as well as lighting requirements to provide good visibility. The advantage of focusing on the built environment is that many characteristics are modifiable. Consequently, the built environment is a prime target for policymakers who wish to prevent burglary.

Despite the wide application of CPTED principles, the empirical base on which the CPTED concepts are founded is limited. Below we discuss several limitations that exist and explain the approach used in this study to address them.

First, with some exceptions (Armitage, 2007; Brown & Altman, 1983; Reynald, 2009, 2011), observations have not been used to systematically measure the CPTED concepts and study their relation with residential burglary. The present research uses observations to measure the CPTED characteristics.

Second, no systematic evaluation has been conducted to differentiate between the six concepts and further differentiated them. For example, some aspects of CPTED relate to characteristics of the property, but some to the immediate surroundings of the property. Aspects of the property are the responsibility of the owner, whereas the immediate environment is most often the responsibility of the (local) government. The comparison of the effectiveness of property-related versus property surrounding characteristics is therefore relevant from an urban management viewpoint. The present study will analyze the findings based on these two levels.

Third, studies investigating the CPTED principles seldom control for a number of important possible interfering factors, such as target attractiveness, offender distribution and social cohesion. An alternative hypothesis to the CPTED approach is that motivated individuals may not be deterred easily by environmental characteristics. Despite research evidence showing the relevance of protection measures (Bernasco & Luykx, 2003; Ratcliffe, 2003; Rossmo, 2000), it is possible that motivated burglars find their way into a property, regardless of whether it is adequately protected or not (Compton, Conway, Stinson, Colliver, & Grant, 2005). Contradictory findings have been reported with respect to the relationship between the socioeconomic characteristics of houses and neighborhoods and burglary. For example, household income was linked with higher rates of burglary in the United Kingdom and lower rates in the United States (Tseloni, Wittebrood, Farrell, & Pease, 2004). Malczewsk and Poetz (2005) reported that both low and high socioeconomic areas can have relatively high burglary rates. It is possible that within low-income neighborhoods, burglars prefer the "richer looking" houses (Shaw & Gifford, 1994). Tilley and Webb (1994) showed that the relationship between income, burglary, and security is complex and that it varies over time (e.g.,

1998 vs. 2005) and by security level. Burglars themselves report a preference for high-income properties (Brown & Bentley, 1993), a view that is supported by Tilley and Webb. Furthermore, neighborhood cohesion may be important in explaining the occurrence of crime (Sampson & Groves, 1989; Sampson, Morenoff, & Gannon-Rowley, 2002; Sampson & Raudenbush, 1999). The present study will control for target attractiveness, residential stability, ethnic heterogeneity, and offender availability.

Fourth, studies usually consider burglaries as a homogeneous phenomenon. This is a remarkable omission, since many aspects of human activities differ greatly not only by location but also by time of the day (L. E. Cohen & Felson, 1979; Felson & Boba, 2010). Only a limited amount of research investigated the impact of time of the day on the risk of burglaries. However, these studies found some intriguing effects of CPTED concepts in combination with the time of day on the prevalence of burglaries. Below the meaning and scope of the six CPTED concepts are discussed and possible differences by time of day are presented.

Territoriality

Territoriality refers to the legitimate users' sense of ownership or appropriation which reduces the opportunities for offending by discouraging illegitimate users (Cozens et al., 2005) and explains the overlaps between this concept and others (e.g., access control and surveillance). Territoriality aims to eliminate unassigned spaces and ensure that all spaces have a clearly defined and designated purpose. According to Newman (1996), people perceive space as being either private, semi-private, semi-public, or public and their expectations and level of involvement in caring for and protecting it varies across these types. Newman considers that back gardens are private because they belong to individual families and are only accessible from the inside of each unit. The front gardens also belong to individual families, but because they are accessible from the street as well as from the inside of each unit, their character is different. "I have classed them as semiprivate because of this difference, but some people would say that they are really private" (Newman, 1996, p. 15). To summarize, accessibility also influences the character of a space.

Territoriality includes symbolic barriers such as signage, artwork, texture change, or road surface color (Armitage, 2006) or an overhead arch between two buildings that creates a sense of private space (Kumar-Kaytal, 2002).

The perception of territoriality varies across cultures, neighborhoods, and individuals (Anderek, 1997; Brunson, Kuo, & Sullivan, 2001; Merry, 1981) and thus the sense of ownership of individuals toward the public and

semi-public space. The concept is therefore somewhat controversial but enhanced levels of territoriality have been associated with lower levels of crime and fear of crime (Brown, 2001; Brown & Bentley, 1993; Brunson et al., 2001; Chainey & Ratcliffe, 2005; Hedayati Marzbali, Abdullah, Razak, & Maghsoodi Tilaki, 2012; Perkins & Taylor, 1996; Wortley & McFarlane, 2009).

Territoriality has different implications for day- and night-time burglaries. Brown and Altman (1983) report that symbolic and actual barriers and identity markers predict daytime burglaries: traces of presence, symbolic and actual barriers, identity markers, and lower visibility lead to relatively low rates of daytime burglaries. They indicate that these factors are less important for the occurrence of night-time burglaries.

Surveillance

Surveillance strategies increase the offender's perception of being observed so that the potential crime benefits are outweighed due to a perception of higher apprehension risk. There are three types of surveillance strategies: informal/natural, formal/organized, and mechanical.

Visibility of properties creates natural surveillance and therefore decreases burglary risk. Burglars avoid targets readily overlooked by passers-by or neighbors (Sorenson, 2003). Properties with thick vegetation, high walls/fences, and front doors hidden in niches provide concealment opportunities for burglars, particularly when close to access points such as windows and doors (Kuo & Sullivan, 2001). Architectural features of the house itself which obscure front doors also increase burglary risk (Weisel, 2002). Intervisibility has been long acknowledged as an important factor (Cozens et al., 2001; Hillier & Shu, 2000; Newman, 1996; Robinson & Robinson, 1997). Dog ownership seems to be a substantial deterrent since burgled houses are less likely to have dogs (Nicholson, 1994).

Formal or organized surveillance can be provided by citizen patrols, private security guards, and through CCTV systems. Research on CCTV, however, has so far found that its effect is either modestly significant (Welsh & Farrington, 2008), unclear (van Noije & Wittebrood, 2008), or not very effective (Gill & Spriggs, 2005). Burglars consider that urban security guards pose the greatest threat to their activities (Clarke, 2003). Experimental studies support the effectiveness of formal surveillance (Barclay, Buckley, Brantingham, Brantingham, & Whinn-Yates, 1996; Bennett, Holloway, & Farrington, 2008; Pennell, Curtis, Henderson, & Tayman, 1989).

A considerable amount of research has been conducted on the decrease of surveillance opportunities after dark (Cozens, Neale, Whitaker, Hillier, &

Graham, 2003). A meta-analysis of lighting and crime (Farrington & Welsh, 2002) found that improved street lighting reduced recorded crime overall in both the United States and the United Kingdom. In addition, it showed reductions in recorded daytime crime, suggesting secondary benefits such as increasing social cohesion and control. Moreover, there was an increase in the number of people in the street after dark, particularly of women (Vito, Maahs, & Homes, 2006) which is the result of the decrease in fear of crime.

Research also found that the effectiveness of visibility to prevent burglary differs by day and by night. Brown and Altman (1983) found that surveillance matters more by day than by night. Similar findings were reported by Coupe and Blake (2006). They found that daytime burglars select targets with good cover, low surveillance (i.e., low visibility from neighbors), and burgle detached or semi-detached houses in low-density housing neighborhoods. In contrast, offenders more often target townhouses in high-density housing neighborhoods during the night-time. Surveillance therefore mattered less by night. While daytime burglaries more often involve unoccupied houses, night-time burglaries often involve owner-occupied houses (Coupe & Blake, 2006). These different strategies have detection implications as the risk of being spotted and hence of being arrested is higher for day- than for night-time burglaries (Coupe & Blake, 2006). Based on this research, it is to be expected that surveillance is strongly related to day- but not to night-time burglaries.

Access Control

Access control focuses on reducing opportunities for crime by denying access to potential targets and increasing risk perception in offenders. Most research on neighborhood access has focused on permeability and traffic levels. Permeability represents access control because it relates to the accessibility or interconnectivity of roads, while traffic levels represent activity support. Crime levels are higher in more permeable, accessible, well-used street networks (Coleman, 1985; Cozens, 2008; Cozens & Love, 2009; Johnson & Bowers, 2010; Newman, 1972; Poyner, 1983; Poyner & Webb, 1991). Proximity to major thoroughfares increases residential burglary risk (Weisel, 2002). Furthermore, leaky cul-de-sacs (i.e., those connected by footpaths) experience higher levels of crime (Armitage, 2006) and sinuous non-leaky (i.e., true) cul-de-sacs lower ones (Armitage, 2011). Moreover, experiments show that street closures on a grid street layout increased housing values whilst fear of crime as well as total recorded and violent crime decreased (Newman, 1996). Accessibility was found to be the most important predictor of burglary in South Korea (Chang, 2011).

Regarding building and property access, fences serve the purpose of making access difficult and hindering the exit of a burglar, although they can also hide the burglar (Weisel, 2002). Side or back entries are the most common access point for burglars (Brantingham & Brantingham, 1984). In terms of the house type, corner houses offer easier access and escape (Siegel, 2009; Weisel, 2002).

Daytime and night-time burglaries focus on different type of houses (Coupe & Blake, 2006). Daytime burglars target detached, semi-detached, low-density houses in higher income neighborhoods, while night-time burglars target townhouses in lower income neighborhoods. Burgled houses are more often accessed by the front door during the day, while access is more often through the rear window during the night-time (Coupe & Blake, 2006). It is remarkable that daytime burglars prefer to break in through the front door even when a back door is present. According to Coupe and Blake (2006), this shows that burglars are only partially rational decision-makers. It is therefore expected that different types of houses will be burgled by day and by night.

Target Hardening

Target hardening increases the efforts that offenders must spend in the commission of a crime and is the oldest prevention approach (Cozens et al., 2005). It involves denying or limiting access to a crime target by using physical barriers (e.g., alarms, locks). The upgrading of locks, doors, and window frames is a common burglary reduction strategy (Allatt, 1984; Weisel, 2002). Experimental research found significant reduction in burglaries in target-hardened English housing estates (Tilley & Webb, 1994). Daytime burglaries more often involve detached and semi-detached houses, which generally have better security than the townhouses that are targeted by night (Coupe & Blake, 2006). No direct relation between the presence of target hardening measures and day- versus night-time burglaries was reported by Coupe and Blake (2006). No expectation can therefore be formulated on target hardening and day- versus night-time burglaries.

Image/Maintenance

The relation between the physical condition and "image" of the built environment and crime and the fear of crime has long been acknowledged (Lynch, 1960). However, there are conflicting views as Wright and Decker (1994) consider that when selecting targets, burglars relate the size and condition of a house and the type of cars in the driveway to the type and value of the

house's contents. In other words, the bigger and the better maintained the house, the higher the potential loot and hence the higher the burglary risk. However, most studies have concluded that the routine maintenance of the urban environment significantly reduces crime (Hedayati Marzbali et al., 2012; Pruitt, Jeffe, Yan, & Schootman, 2000; Ross & Mirowsky, 1999; Taylor, 1991) and more specifically, the rapid repair and renovation of vacant or derelict buildings (Cozens et al., 2001).

No studies have investigated maintenance in relation to the time of day of a burglary. However, several associations might be anticipated. On the one hand, it seems possible that maintenance matters less by night due to low visibility, while on the other hand, the findings of Coupe and Blake (2006) suggest that the effect of maintenance might be confounded with the differences in target selection strategies of day- versus night-time burglars. Daytime offenders tend to choose (semi)detached houses in high-income neighborhoods, that are probably well-maintained, whereas night-time offenders choose townhouses in low-income neighborhoods, which are probably not so well-maintained. This therefore suggests that it is necessary to control for neighborhood income.

Activity Support

The principle of activity support is mainly attributed to Jacobs (1961), but the New Urbanism movement has widely disseminated it. This principle argues that the generation of activity by ordinary citizens discourages criminal action and more specifically, the placing of "safe" activities attracts ordinary citizens who may act to discourage the presence of criminals (Congress for the New Urbanism Members, 1996). The systematic zoning of areas for particular uses reduces the number of potential "eyes on the street" (Jacobs, 1961), while mixed land-use patterns contribute to a safer, more vital public realm (Zelinka & Brennan, 2001). Some studies support this view and conclude that opportunities for crime are reduced by increasing the range of activities in both spatial and temporal terms (Bohl, 2000; Bothwell, Gindroz, & Lang, 1998; Petterson, 1997; Poyner & Webb, 1991). In addition, busier streets with some pedestrian movement have reduced levels of recorded crime (Cozens, 2008; Knowles, 2006; Town, Davey, & Wooton, 2004). However, in contrast with these views, many studies on crime found that mixed land-use increases crime (Cozens & Hillier, 2008; Knowles, 2006; Reynald, 2011; Town & O'Toole, 2005). No studies have looked at activity support by day and by night in relation to burglaries. The inconsistent activity support findings make it difficult to anticipate what impact it has on day- versus night-time burglaries.

Other issues have been associated with day- versus night-time burglaries. Daytime burglars differ in several respects from night-time burglars (Coupe & Blake, 2006). Older offenders choose to operate alone at night usually relatively close to home. Daytime burglars often travelled three times as far by car to targets. Younger offenders commonly perpetrated daytime burglary in pairs and on foot, exposing themselves to greater risks of being seen and arrested (Coupe & Blake, 2006). Younger offenders also seemed more averse to victim encounters, in contrast with older offenders who often risked encountering a victim when burgling occupied houses at night (Coupe & Blake, 2006). Finally, Brown and Altman (1983) found that daytime burglaries are easier to predict since the explained variance (i.e., R^2) for daytime burglaries is .33 while for night-time burglaries it is .06.

To conclude, there is evidence of distinctive and consistent differences between day- and night-time burglary. Daytime burglars target low-density, less-guarded up-market houses that have vegetation cover. Night-time burglars target down-market and more heavily guarded properties (Coupe & Blake, 2006). They also conclude that day- and night-time burglars are two different categories of offenders that choose two distinct burglary strategies.

To summarize, this study examines how residential property and its surroundings influence day- and night-time residential burglary. CPTED principles of territoriality, surveillance, access control, target hardening, image maintenance, and activity support underpin the study. Based on the above review, it is to be expected that territoriality and surveillance are strongly related to daytime burglaries but not to night-time burglaries. Dimensions of access control should also have a different impact by day or by night. No expectation can be formulated on target hardening, maintenance and activity support, and day- versus night-time burglaries. Information on neighborhood characteristics is collected from the Dutch Bureau of Statistics, the municipality, and the police. Data are collected by observing 851 houses, half of which had been burgled.

Method

Sample

The study was carried out in Enschede, a city along the Dutch-German border. In 2008, the city had approximately 155,000 inhabitants (http://enschede.buurtmonitor.nl) and a residential burglary rate of 1.02%. There were 70 neighborhoods in 2008 and an average of 7,614 residential addresses per neighborhood. The average size of a neighborhood is 207 Ha (minimum of 25 Ha, median of 68 Ha, and maximum of 2,981 Ha; Centraal Bureau voor de Statistiek, 2009).

The research was designed as a case-control study. A case-control study involves the identification of "individuals" with ("cases") and without ("controls") a particular condition. The prevalence (or level) of exposure to a factor is then measured in each group. If the prevalence of exposure among cases and controls is different, it is possible to infer that the exposure may be associated with an increased or decreased occurrence of the outcome of interest (Dos Santos Silva, 1999). The cases are houses burgled between January 2008 and mid-May 2010. The definition of house used throughout this research includes houses and only apartments located at the ground level. Apartments above the ground floor were excluded since these lack many of the observed characteristics (e.g., gardens, fences).

The controls were selected randomly by the municipality of Enschede, out of a list containing all properties in the city. Four hundred and twenty-one houses were selected at random from this list. Four houses were not observed as they did not meet this study's definition of residential property (refer to section "Concepts"). It was deemed unsuitable to select a neighboring house or a house from the same street as a control case due to "near repeat" victimization since research (Bernasco, 2008; Bowers & Johnson, 2004; Townsley, Homel, & Chaseling, 2003) shows that houses located near a burgled house have a higher victimization risk. Moreover, the method of randomly sampling the controls is the standard (Shadish, Campbell, & Cook, 2002). Out of the 851 houses observed, 434 were burgled (the cases) and 417 were not (the controls).

Data Collection

The observation form that was used to collect information was based on a design by the University of Huddersfield (Armitage, 2006) and it was adapted to the Dutch context during a pilot phase. The most important adaptation related to the inclusion of proximity to non-residential activities and cycling-related characteristics. To ensure a homogeneous interpretation of residential property characteristics, the group carried out two test field visits during a trial period. Differences identified in the coding were discussed and an appropriate guideline was developed to standardize coding.

The data collection was carried out by observing the houses from the sidewalk or footpath. It was performed by a team of 6 observers and took place in 2010 from mid-February to mid-May. The observers were unaware whether the houses had been burgled or not. To increase reliability, the observation work was restricted to weekdays from 10 a.m. to 3 p.m. Although the weather dependency of some variables (e.g., traffic levels) could bias the results, most surveyors went to the field when the weather was reasonable or good.

Concepts

The Dutch police definition of burglary was used: "the theft from a house and/or attached storeroom, garage, shed, etc." Burglary was measured using a four category variable: (a) not burgled, (b) burgled during the day, (c) burgled during the night, (d) burgled during both day and night (i.e., dual day/night). The time of the burglary is listed in police records as a "start" and an "end" time.

Time of day. A measurement problem emerges from the literature. Most studies either do not indicate how the day was split into day and night or divide it based on, for example, a 6 a.m. to 6 p.m. timetable (D'Alessio, Eitle, & Stolzenberg, 2012) instead of based on actual sunrise and sunset information. The present study uses actual sunrise and sunset information. The average time of the burglary together with the Enschede sunrise/sunset data (http://www.timeanddate.com) were used to classify burglaries into day and night time.

Management level refers to whether the variables relate to individual property characteristics or whether they relate to features of the property surroundings and therefore to features that the home owner has little or no control over. Table 1 contains, for each CPTED concept, the list of characteristics (i.e., house plus its parcel [P] or property surroundings [PS]) evaluated in the analysis. "Expectation" indicates whether the characteristic was assumed to be associated with higher (+) or lower (−) burglary in general. A third of the items had been used by Armitage (2006), namely, Items 2, 5, 7, 10, 14, 15, 19, 20, 25, 29, 31, 32, 39, 41, and 42.

All the CPTED variables were dichotomized with "zero" representing absence of the specific characteristic and "one" representing presence of it. The initial data collection consisted of several categories per variable but dichotomization was necessary to reduce the number of degrees of freedom in the regression model. The cut points used for the dichotomization were selected based on the literature. As many variables were relatively skewed, there was little information loss. Attention was paid to maximize variance. In the case of meaningful information loss due to dichotomization, some variables with different categories were split into several dummy variables. Due to space limitations, the descriptive statistics of the dichotomous independent variables were simplified by describing them as if these were continuous variables (see Table 2).

Five neighborhood-level control variables were used. Target attractiveness was measured using the average property value in thousands of Euros. Residential stability was measured using the percentage of home owners and the length of stay in the neighborhood of the household head expressed in

Table 1. Description of Characteristics Evaluated for Each CPTED Concept.

ICC	Expectation	Concept/characteristic	Description
		Territoriality	
0.877	−	1. Front garden (P)	Front paved or unpaved garden
0.264	−	2. Symbolic or physical barriers (PS)	Changes in texture/design or signs/ landmarks delimiting a neighborhood
		Surveillance	
n/a[a]	−	3. Guardianship by home owners (P)	Home owners observe the coding work. Coder observed by owner eye contact or opening or curtains.
n/a	−	4. Guardianship by neighbors (PS)	Idem
1	−	5. Visibility from road junction (PS)	Front façade of house visible from nearest road junction
1	−	6. Visibility of main door (P)[b]	Main door visible from the sidewalk
0.588	+	7. Surveillance potential by passing vehicles (PS)	Speed limit in road segment >50 km/h
0.520	+	8. Main door design (P)	Front door located in a niche
0.215	−	9. Neighbors across (PS)	There is a house across the street
zv[c]	−	10. Organized surveillance (PS)	Signs or stickers alert about the existence of a neighborhood watch programme
0.557	−	11. House on a square (PS)	House located on a square
zv	−	12. Street lighting (PS)	Street lights along the sidewalk
0.034	−	13. Visibility into back garden (P)	Back garden visible from footpath or sidewalk
0.334	−	14. Human presence on street (PS)	People present on the street, not passers-by but people either waiting for someone/something or chatting to others
zv	−	15. Dog evidence (P)	Dog sticker on door or dog either seen or heard
		Access control	
0.852	−	16. Detachment (P)	House is terraced (i.e., adjoining)
0.697	−	17. Front garden enclosure (P)	Fence around the front garden
0.478	−	18. Height of garden fence (P)	Fence height of the front garden > = 1.8 m
n/a	−	19. Neighborhood accessibility (PS)	Road is a cul-de-sac without exit (i.e., no through)
0.818	+	20. Position along footpath (PS)	House is the first one along a footpath
−0.096	+	21. Accessibility into back garden (P)[d]	Door on back garden fence or no fence
0.788	+	22. Homogeneous house design (PS)	Houses in the neighborhood share the same floor layout
0.371	+	23. Location of side entrance door (P)	Door at the front of the side entrance
zv	+	24. Bicycle path (PS)	Bicycle path behind the house
0.445	+	25. Footpath (PS)	House along a footpath
0.687	+	26. Corner house (P)	House located on a corner of the block
		Target hardening	
0.415	−	27. Secure-by-design national scheme (P)	House built after 1990, after the launch of the Police Marque Secure Housing

(continued)

Table 1. (continued)

ICC	Expectation	Concept/characteristic	Description
0.375	−	28. Window screening (P)	Metal shutters on ground floor windows
zv	−	29. Alarm evidence (P)	Alarm warning sticker or alarm system components are visible
zv	−	30. Movement detection (PS)	Movement detector lighting outside
		Image maintenance	
0.359	−	31. Maintenance neighborhood (PS)	No signs of due maintenance of neighboring houses
0.164	−	32. Maintenance house (P)	No signs of due maintenance of house
0.156	−	33. Maintenance window/door frames (P)	No signs of due maintenance of house's window/door frames
0.882	−	34. Front garden image (P)	Front garden attractive or has special features in relation to nearby ones
		Activity support	
0.415	−	35. Proximity to recreational facilities (PS)	House within 100 m of a playground or sports ground
0.560	−	36. Proximity to commercial establishments (PS)	. . . retail or wholesale establishments
0.480	−	37. Proximity to educational establishments (PS)	. . . primary, secondary or higher education establishment
0.810	−	38. Proximity to religious facilities (PS)	. . . church, mosque or synagogue
0.139	+	39. Neighborhood vehicle traffic (PS)	6 to 10 vehicles pass every 3 min
0.220	+	40. Neighborhood cycling traffic (PS)	6 to 10 bicycles pass every 3 min
0.403	+	41. Pedestrian traffic on street segment (PS)	6 to 10 pedestrians pass every 3 min
0.676	+	42. Vehicle traffic on street segment (PS)	6 to 10 vehicles pass every 3 min
		Neighborhood control variables	
	+	43. Offender availability	% Suspected residential burglars
	−	44. Home ownership	% Owners
	−	45. Length of stay	Length of stay in years of household head
	−	46. Social cohesion	% Ethnic Dutch
	+	47. Target attractiveness	Property value in thousand Euros

Note. "Expectation" indicates if it is assumed to increase (+) or decrease (−) burglary in general. Management levels are indicated: property (i.e., house plus its parcel [P] and property surroundings [PS]) as well as if it appears in Armitage's (2006) study. ICC indicates the interrater reliability. CPTED = Crime Prevention Through Environmental Design; ICC = intraclass correlation.

[a]Non applicable.

[b]Armitage evaluated whether the door faces the street and not whether it is visible from the street.

[c]Zero variance.

[d]Armitage evaluated property boundary in general and not broken down into front and back garden boundary.

years. Ethnic heterogeneity was measured by means of the percentage of ethnic Dutch. Information on these characteristics was collected at the municipality. Research has shown that Dutch neighborhoods are relatively

Table 2. Descriptive Statistics Showing the Proportion of Burgled and Non-Burgled Houses in Relation to CPTED Concepts and Standard Deviations.

					Burgled (n = 434)			
	Bivariate p level		Not burgled (n = 417)		Proportion		*SD*	
Concept/characteristic	Day	Night	Proportion	*SD*	Day (n = 145)	Night (n = 280)	Day	Night
Territoriality								
1. Front garden	***	**	0.72	0.45	0.55	0.61	0.50	0.49
2. Symbolic or physical barrier		†	0.11	0.31	0.09	0.07	0.29	0.25
Surveillance								
3. Guardianship by residents			0.04	0.20	0.02	0.05	0.15	0.21
4. Guardianship by neighbors			0.07	0.25	0.09	0.09	0.28	0.28
5. Visibility from road junction		†	0.29	0.46	0.35	0.23	0.48	0.42
6. Visibility of main door			0.98	0.15	0.97	0.98	0.18	0.13
7. Surveillance by passing vehicles			0.11	0.31	0.13	0.10	0.34	0.30
8. Main door design			0.24	0.43	0.27	0.24	0.45	0.43
9. Neighbors across	*		0.89	0.31	0.82	0.89	0.39	0.32
10. Organized surveillance			0.03	0.17	0.03	0.03	0.16	0.18
11. House on a square		†	0.22	0.42	0.17	0.29	0.38	0.45
12. Street lighting			1.00	0.07	0.99	0.99	0.08	0.10
13. Visibility into back garden	**	**	0.12	0.33	0.22	0.20	0.41	0.40
14. Human presence on street		†	0.17	0.38	0.12	0.12	0.32	0.33
15. Dog evidence		*	0.05	0.22	0.05	0.02	0.22	0.13
Access control								
16. Detachment (i.e., adjoining, terraced)	**		0.44	0.50	0.30	0.38	0.46	0.48
17. Front garden enclosure	***	**	0.72	0.45	0.54	0.61	0.50	0.49
18. Height of garden fence			0.02	0.13	0.03	0.01	0.17	0.10
19. Neighborhood accessibility			0.03	0.16	0.03	0.03	0.17	0.16
20. Position along footpath			0.23	0.42	0.28	0.26	0.45	0.44
21. Accessibility into back garden	†		0.77	0.42	0.85	0.80	0.36	0.40
22. Homogeneous house design			0.58	0.49	0.52	0.55	0.50	0.50
23. Location of side entrance door		†	0.09	0.28	0.13	0.13	0.33	0.34
24. Bicycle path	†		0.05	0.21	0.01	0.07	0.12	0.25
25. Footpath			0.60	0.49	0.57	0.64	0.50	0.48
26. Corner house (i.e., end house)	**		0.08	0.28	0.17	0.08	0.38	0.28
Target hardening								
27. Secure-by-design national scheme			0.15	0.36	0.12	0.15	0.32	0.35
28. Window screening		*	0.10	0.30	0.07	0.06	0.26	0.23
29. Alarm evidence			0.07	0.25	0.07	0.07	0.25	0.25
30. Movement detection			0.10	0.30	0.08	0.09	0.28	0.28
Image maintenance								
31. Maintenance neighbors	†	†	0.87	0.34	0.81	0.82	0.40	0.39
32. Maintenance house	**		0.85	0.35	0.75	0.81	0.43	0.39
33. Maintenance window/door frames	*	*	0.91	0.29	0.83	0.86	0.37	0.35

(continued)

Table 2. (continued)

Concept/characteristic	Bivariate *p* level		Not burgled (*n* = 417)		Burgled (*n* = 434)			
					Proportion		*SD*	
	Day	Night	Proportion	*SD*	Day (*n* = 145)	Night (*n* = 280)	Day	Night
34. Front garden image		*	0.13	0.34	0.09	0.08	0.29	0.28
Activity support								
35. Proximity to recreational establishments	*		0.27	0.44	0.17	0.23	0.38	0.42
36. Proximity to commercial establishments	*		0.44	0.50	0.56	0.44	0.50	0.50
37. Proximity to educational establishments			0.13	0.33	0.12	0.12	0.32	0.32
38. Proximity to religious establishments	*		0.04	0.19	0.08	0.03	0.27	0.18
39. Neighborhood vehicle traffic			0.05	0.21	0.06	0.05	0.23	0.22
40. Neighborhood cycling traffic			0.03	0.17	0.04	0.04	0.20	0.19
41. Pedestrian traffic on street segment			0.04	0.19	0.03	0.04	0.18	0.20
42. Vehicle traffic on street segment			0.10	0.30	0.08	0.11	0.28	0.31
Control variables								
43. Offender availability	*	**	0.10	0.09	0.12	0.12	0.10	0.11
44. Home ownership	***	†	50.55	21.62	43.29	47.37	20.50	21.69
45. Length of stay	**	**	12.57	2.45	11.80	11.96	2.59	2.61
46. Social cohesion	**	*	72.40	9.49	69.84	70.64	8.60	9.66
47. Target attractiveness	*		173.95	64.88	161.10	169.81	47.00	56.52

Note. CPTED = Crime Prevention through Environmental Design.
†$p < .10$. *$p < .05$. **$p < .01$. ***$p < .001$.

homogeneous (Wittebrood & van Dijk, 2007). In addition, in cities such as Enschede, neighborhoods tend to be even more homogeneous than in less urbanized environments (Knol, 2012). Offender availability was measured using the percentage of suspected residential burglars in a neighborhood, as recorded by the police.

As the team consisted of six different observers, reliability analysis was performed immediately before the start of the observations. Twenty randomly selected properties, of which half were burgled, were observed by all coders. The intraclass correlation (ICC) coefficients were computed for all variables. The ICC consists of a ratio between rating variance to total variance, and compares the covariance of the ratings with the total variance (Shrout &

Fleiss, 1979). For 9 of the 42 house and neighborhood characteristic variables used in this study, it was impossible to compute the ICC, as there were not enough cases. For example, the coding was inapplicable for a variable describing a footpath if there was no footpath. Alternatively, a variable could have had zero variance if all or most coders assigned the same code in the 20 randomly selected properties (e.g., whether or not the house was a bungalow). For 33 variables that yielded an ICC, 2 had perfect agreement (ICC = 1), and 23 (70%) had an ICC of 0.40 or higher, which represents medium to high correlation values (J. W. Cohen, 1988).

Analyses

Cross-tabular statistics and Pearson chi-square values tested the relationship between a given dichotomous independent and the dichotomous dependent variable. For continuous variables, an independent-sample *t* test was used. This analysis is presented in a table of descriptive statistics which contains all four possible outcomes: (a) not burgled, (b) burgled during the day, (c) burgled during the night, (d) burgled during both day and night (i.e., dual day/night). As there were very few houses burgled both during the day and night, these nine cases were dropped from the regression modeling to avoid the violation of sample size regression assumptions.

Second, multilevel multinomial regression models were estimated for each CPTED concept using structural equation modeling to obtain predictive models of day- and night-time burglary. Multilevel regression was used since the average correlation between the variables measured on houses from the same neighborhood is higher than that of houses from other neighborhoods (see Table 3). Failing to account for it results in large biases in the standard errors. The group-level variable used was the neighborhood defined by the Dutch Census Bureau (CBS) as an area of homogeneous land use. The variance inflation factor (i.e. VIF), a diagnostic measure of multicollinearity, indicated that two (control) variables have values above 4 (i.e., home ownership = 4.31; social cohesion = 4.13). The variable "home ownership" was therefore dropped; this is not considered problematic from the theoretical point of view since "length of stay" also represents residential stability. After its removal, the VIF values were below 2.18.

Finally, on the basis of the individual CPTED regressions, a multilevel multinomial logistic regression model of day- and night-time burglary was elaborated using only those variables with *p* values below .10 on either the day- or the night-time parts of the model.

Table 3. Multilevel Multinomial Regression Model (*N* = 788).

			Confidence interval	
	RRR	*SE*	Lower 95%	Upper 95%
Daytime				
Level 1 variables (i.e., fixed)				
Territoriality				
1. Front garden	0.46***	0.11	0.29	0.74
Surveillance				
12. Street lighting	0.64	0.83	0.05	8.26
13. Visibility into back garden	1.54	0.43	0.88	2.67
14. Human presence on street	0.63	0.21	0.33	1.19
15. Dog evidence	0.89	0.43	0.34	2.32
Access control				
16. Detachment (i.e., adjoining, terraced)	0.55*	0.14	0.33	0.89
21. Accessibility into back garden	1.46	0.41	0.84	2.32
24. Bicycle path	0.31	0.24	0.07	1.43
26. Corner house	1.97*	0.67	1.01	3.85
Target hardening				
22. Homogeneous house design	0.88	0.21	0.55	1.39
28. Window screening	0.49†	0.20	0.22	1.09
Image maintenance				
34. Front garden image	0.78	0.29	0.37	1.61
Activity support				
35. Proximity to recreational establishments	0.69	0.19	0.39	1.19
36. Proximity to commercial establishments	1.45†	0.32	0.94	2.23
37. Proximity to religious establishments	1.90	0.90	0.75	4.80
Level 2 Neighborhood variables (i.e., random)				
43. Offender availability	2.15	2.89	0.15	29.92
45. Length of stay	0.89*	0.05	0.81	0.99
Cons	2.85	4.39	0.14	58.15
Night-time				
Level 1 variables (i.e., fixed)				
Territoriality				
1. Front garden	0.72†	0.14	0.49	1.06

(continued)

Table 3. (continued)

			Confidence interval	
	RRR	*SE*	Lower 95%	Upper 95%
Surveillance				
12. Street lighting	0.44	0.44	0.06	3.05
13. Visibility into back garden	1.61†	0.38	1.01	2.56
14. Human presence on street	0.68	0.17	0.42	1.11
15. Dog evidence	0.36†	0.19	0.13	1.01
Access control				
16. Detachment (i.e., adjoining, terraced)	0.68*	0.13	0.46	1.00
21. Accessibility into back garden	1.17	0.25	0.77	1.77
24. Bicycle path	1.80	0.68	0.86	3.78
26. Corner house	0.88	0.28	0.47	1.65
Target hardening				
22. Homogeneous house design	0.96	0.18	0.66	1.39
28. Window screening	0.44*	0.15	0.23	0.84
Image maintenance				
34. Front garden image	0.67	0.20	0.38	1.20
Activity support				
35. Proximity to recreational establishments	0.82	0.18	0.54	1.25
36. Proximity to commercial establishments	0.97	0.17	0.69	1.38
37. Proximity to religious establishments	0.88	0.44	0.32	2.32
Level 2 Neighborhood Variables (i.e., random)				
43. Offender availability	11.58*	13.08	1.27	105.99
45. Length of stay	0.95	0.04	0.87	1.04
Cons	3.20	3.84	0.31	33.63
Intercept Level 2 variables				
variance (neighborhood)	0.19	0.11		

Note. Front garden fence (access control variable) omitted from the model due to correlation with front garden. RRR = relative risk ratio.
†$p < .10$. *$p < .05$. **$p < .01$.

Results

Out of the 443 burglaries that took place on the 434 houses, 34.7% took place during the day and 65.3% during the night. In all, 2.07% of the burgled houses had both a day- and a night-time burglary. Table 2 summarizes the results of the descriptive statistics of the 42 dichotomous and 5 continuous control variables. It also presents the bivariate analyses between daytime, night-time burglary, and dual day/night-time and each of the characteristics. A notable finding from the bivariate analysis is that for daytime burglary, the characteristics "visibility into back garden," "proximity to commercial facility, and proximity to religious facility" have a significantly opposite expected effect. That is, it is not only the opposite of what was expected, but it is not likely that this result happened by chance.

For comparability, the model contained the same 17 variables in the day- and night-time parts of the model (2 of which were control variables).

Daytime Burglary

The model shows that daytime burglary is related to territoriality and access control. Specifically, having a front garden associated with lower daytime burglary, while holding all other variables constant (RRR[1] = 0.46, for example, houses that have a front garden have 0.46 times lower risk of being burgled than those that do not have such feature). Being an un-detached house is also associated with lower daytime burglary risk (RRR = 0.55). This model also suggests that the factor that is associated with higher daytime burglary is being a corner house (RRR == 1.97, that is, corner houses have 1.97 times higher risk of being burgled than those which are not located at the corner of a street). Neighborhood stability reduces the likelihood of daytime burglaries (RRR = 0.89). Proximity to commercial establishments (i.e., activity support) and window screening (i.e., target hardening) were on the verge of statistical significance (RRR = 1.45 and 0.49, respectively).

Night-Time Burglary

The model shows that night-time burglary is related to access control and target hardening. The results show that being an un-detached house is associated with lower night-time burglary, while holding all other variables constant (RRR = 0.68). Window screening is also associated with lower night-time burglary risk (RRR = 0.44). Being an un-detached house was significant for both day- and night-time burglary. Three variables were on the verge of statistical significance. Having a front garden (i.e., territoriality),

visibility into the back garden and dog evidence(i.e., surveillance) are associated with a decrease in night-time burglary risk (RRR = 0.72, 1.61 and 0.36, respectively). Finally, offender availability was associated with a large increase in burglary risk (RRR = 11.58).

Discussion

The aim of this study was to investigate whether (a) burgled houses and non-burgled houses differ with respect to the CPTED concepts and whether (b) a day and night effect exists. To account for several plausible alternative explanations, the analysis controlled for target attractiveness, social cohesion, and offender availability. In addition, the multilevel analysis took the ICC (i.e., nesting within neighborhoods) into account.

Two general findings should be noted. First, this study found that 34.7% of the burglaries took place during the night while 65.3% took place during the daytime. This is not dissimilar to findings of the study of van den Handel, Nauta, van Soomeren, and van Amersfoort (2009) that investigated all burglaries in the Netherlands and reported that 43% of the burglaries occurred during the daytime and 57% during the night-time. However, in the United States, this proportion is reversed (Criminal Justice Information Services Division, 2009), while in the United Kingdom, half of the burglaries occur during the day and half during the night (Coupe & Blake, 2006). Such differences might be due to our study's use of actual sunrise and sunset information (as opposed to a simplistic 12-hr timetable for each day of the year) to split burglaries into day- and night-time, which was done with the goal of reflecting true light and darkness conditions.

Second, many variables were related to day- or night-time burglaries in the bivariate analysis. However, many of these relationships disappeared in the multivariate analysis. For instance, several measures of image maintenance were related to daytime or night-time burglary, but these vanished in the multivariate analysis. This highlights the importance of multivariate analysis.

Territoriality

CPTED studies reported that houses with front gardens and with symbolic barriers would have a lower risk. In addition, studies that distinguished between day- and night-time burglaries reported that territoriality is important for day but not for night-time burglaries (Brown & Altman, 1983). In line with this finding, one aspect of territoriality was related to burglary: Having a front garden was related to a decrease in daytime burglary. In addition, there

was a tendency for the presence of a front garden to be associated with decreased night-time burglary.

There might be several explanations of why this is important for deterring daytime burglary. First, it might work as a buffer, because potential burglars have more difficulty in seeing what is inside the house. Second, having a front garden might create opportunities for surveillance (this possibility is discussed in the section on surveillance). Our findings thereby support previous research about the importance of territoriality, but qualify it as well: Territoriality is important but only for daytime burglary. It is possible that having a front garden reflects surveillance because people sit or work there and provide informal surveillance. This is likely to be done during the day, explaining why it does not significantly predict night-time burglary. In support of this explanation, Kuo and Sullivan (2001) found that vegetation around buildings is associated with lower levels of crime. They argue that this occurs as a result of increased informal surveillance. In this case, a front garden is not a measure of territoriality but of informal surveillance. Similarly, Donovan and Prestemon (2012) found that vegetation that does not obstruct visibility is associated with lower crime.

Image Maintenance

We examined whether risk is lower when there is good maintenance of (a) the house, (b) neighboring houses, (c) window and door frames, and when (d) the front garden is attractive. In contrast to the findings of other researchers (Hedayati Marzbali et al., 2012; Pruitt et al., 2000; Ross & Mirowsky, 1999; Taylor, 1991; Wilson & Kelling, 1982), this study found that good house or neighborhood maintenance is not associated with lower burglary. It is possible that the relatively homogeneous level of upkeep of Dutch neighborhoods explains why image maintenance does not predict burglary.

Surveillance

Three types of strategies were investigated: informal or natural, formal or organized, and mechanical. It was expected that intervisibility decreased burglary and therefore that houses visible from the road junction, with their entrance (i.e., front door) visible from the street, with a visible back garden, with evidence of a dog, with neighbors across the street and on a square (i.e., an open neighborhood layout) would have a lower risk (Cozens et al., 2001; Hillier & Shu, 2000; Newman, 1996; Robinson & Robinson, 1997). In the same line of thinking, it was expected that houses with their front door in a niche would have a higher risk because this limits informal surveillance (Kuo

& Sullivan, 2001). Lower risk was expected if home owners themselves or their neighbors guarded the houses and if there was human presence on the street (i.e., not passers-by). It was tested whether streets with higher speed limits were associated with higher risk because drivers had reduced surveillance opportunities. Furthermore, both Brown and Altman (1983) and Coupe and Blake (2006) found that surveillance mattered more by day than by night. Our results are not statistically significant, but it should be noted that they are diverging, since surveillance characteristics are associated with both higher and lower risk for both day- and night-time burglary.

There is a tendency for a visible back garden to be associated with higher night-time burglary, which was unexpected. Since a possible explanation was that this reflected "easy" access, the regression model was re-ran (results not shown) with the variable "accessibility into back garden" and the interaction of this with the "visibility into back garden." The opposite expected effect remained; therefore, the most likely explanation is that the visibility allows the offender to identify suitable objects to be stolen (i.e., opportunity) and that this factor is stronger than his perception of higher risk. This illustrates that although conceptually, the CPTED concepts are clear, it is challenging to operationalize them into specific variables, and thus to identify concrete potential preventive measures.

There was a tendency for the evidence of a dog to be associated with decreased night-time burglary. This finding is in line with the view of Nicholson (1994) regarding dog ownership as it was found that evidence of a dog is associated with lower night-time burglary.

In contrast to the findings of Bennett et al. (2008), we found no relation between burglary and neighborhood watch signs. A straightforward alternative explanation was not identified but since only 3% of the sample had neighborhood watch signs, it is difficult to interpret these findings. Research has shown that lighting is associated with lower crime risk (Farrington & Welsh, 2002) but the present findings do not support this.

Access Control

Two access control aspects were investigated: property and road structure. We expected that houses (a) along permeable road layouts, (b) with footpaths, and (c) with bicycle lanes at the back of the property would have higher risk. This study did not support these expectations, in contrast to the findings of Eck (1997), Cozens and Hillier (2008), Newman (1996), Weisel (2002), and Johnson and Bowers (2010). It is possible that the high bicycle use explains why a cul-de-sac without exit does not lower risk. The bicycle's higher mobility compared with that of a car could explain why the road

layout is less important in a country such as the Netherlands. For example, a bicycle can travel over the open grass surface which typically separates low-income apartment buildings in The Netherlands.

Access control is an important deterrent of burglary (Brantingham & Brantingham, 1984; Siegel, 2009; Weisel, 2002). Accordingly, we expected that (a) houses with fenced front gardens have lower burglary risk, particularly when fences are high; (b) un-detached/adjoining houses and houses without entrances to their back gardens have lower risk; (c) the risk is higher for corner houses; and (d) the risk is higher when the door of the side entrance into the garden is near the sidewalk. Un-detached houses are associated with both lower day- and night-time burglary, while corner houses are only associated with higher daytime burglary.

Activity Support

We investigated whether (a) there is lower burglary risk for houses close to buildings used for recreational, educational, commercial, or religious purposes; (b) medium intensity of vehicle and bicycle traffic at the nearest junction is associated with higher risk; and (c) medium intensity of pedestrian and vehicle traffic along the street segment is associated with higher risk. Our findings contrast with those of many (Jacobs, 1961; Petterson, 1997; Poyner, 1983; Zelinka & Brennan, 2001) as no activity support variables were found to be statistically significant in the regression model. There is a tendency for proximity to commercial establishments to be associated with higher daytime burglary risk, which is in contrast to the expected beneficial surveillance effects. Therefore, "activity support" leads to increased risk rather than decreased risk, suggesting that the opportunity effect (i.e., bringing offenders to possible targets) is more important than the possible positive effects of increased surveillance. A possible explanation of the difference with previous research findings is that our study looked at proximity to specific land uses, rather than to land-use density.

Target Hardening

We examined whether (a) new houses built after the launching of the national police secure-by-design housing scheme have lower risk and (b) houses with increased security measures (e.g., alarms, metal shutters, movement lamps) have lower risk. Our findings support previous research that shows relationships between most target hardening measures and burglary risk (Weisel, 2002). Window screening is associated with lower night-time burglary risk. In addition, there was a tendency for it to deter daytime burglary.

However, in line with the present findings, the effectiveness of alarms is controversial. Some studies found that burglar alarms deter break-ins, (Hakim et al., 2001; Triggs, 2005), while others found no relation. For example, LeBeau and Vincent (1998) concluded that "alarms are neither effective nor efficient." Perhaps this study did not detect target hardening measures because data were collected from outside the property boundaries or because objects such as alarms are concealed deliberately.

Regarding the alternative explanation variables, target attractiveness and ethnic heterogeneity were not related to burglary. In line with Sampson, Raudenbush, and Earls (1997), the measure of residential stability, namely length of stay, was associated with lower day- but not to night-time burglary. In addition, offender availability was associated with higher night-time burglary and its relative risk was very high (RRR = 11.58). This finding is in line with Coupe and Blake (2006) who reported a tendency for older offenders to carry out burglaries close to home during the night-time.

Our findings support the rational choice model of crime in the sense that characteristics that deter burglary (territoriality, target hardening, and access control) have an effect on it. The findings provide a qualified support for the CPTED concepts. One aspect of territoriality was important for daytime burglaries and one aspect of target control for night-time burglary. Only one characteristic (i.e., house detachment) was related to both day- and night-time burglary. Most notable is that, apart from one exception, the statistically significant characteristics do not overlap between the daytime and the night-time burglaries. Our conclusion is that two separate property-focused burglary prevention frameworks should be used: one for day and another one for night-time burglary. This is in agreement with the few studies that explicitly distinguished between day- and night-time burglaries, such as Coupe and Blake (2006) and Brown and Altman (1983). More specifically, although the present study differs from the Coupe and Blake study in terms of the method used, the present findings also found a tendency for night-time burglaries to occur in the vicinity of offenders' homes. Length of stay is associated with daytime burglary which demonstrates that person-oriented factors are important in crime prevention as well.

Application and Synthesis

There are a number of practical design recommendations that stem from these findings. For proper decision making, the stakeholder(s) that would be involved in the modification of a particular property or property surrounding characteristic should be first identified. This is necessary as some characteristics involve different individuals or groups (e.g., the owner, the local neighborhood committee, the local planning organizations, or a combination of

stakeholders including private sector such as private housing developers). In addition, further analyses are required before a decision can be made about the selection of measures. First, a study to establish whether there are significant differences in the value of stolen goods by day or night is needed. Second, the time and costs associated with physical adaptation measures should also be evaluated. Without being exhaustive, next some practical recommendations are presented.

Home Owners

The visibility into the back gardens should be blocked by means of fences or tall and dense bushes. Window screening is often seen as an expensive home improvement to reduce crime risk and increase thermal insulation. This research has confirmed that particularly for those who work night shifts, it is a worthwhile option.

Local Governments/Property Developers

At the long-term level and for future housing developments, neighborhoods could be designed with higher percentages of houses with front gardens. Organized surveillance schemes, either via neighborhood groups or police foot or vehicle patrols should pay special attention to corner houses.

In conclusion, this research looked at the effect of the physical characteristics of houses and of their immediate environment on burglary using CPTED concepts. It was found that some concepts are better at explaining burglary than others. In addition, all the significant predictors on the multilevel multinomial model involve property-related characteristics, which highlight burglary being more a house than a neighborhood issue.

It is worth noting that the operationalization of some concepts can highlight ambiguities. For example, some aspects of territoriality (e.g., "front garden") may be better conceived as "informal surveillance." Visibility into the back garden also seems to indicate "opportunity." Our conclusion is that CPTED concepts provide an important framework for studying burglary although further research is needed to fill-in some gaps. Awareness space theory provides the alternative explanation for several of the unexpected effects found in this research. From the management viewpoint, a number of design recommendations were discussed.

Potential Research Design Improvements

There are four areas where the research design could be further fine-tuned. First, the dependent variable does not account for repeat victimization.

Second, the existence of street lights along the sidewalk could be limited by, for example, actual illumination and vegetation. The effective street lighting affecting a house could be therefore assessed instead. Third, the research design (i.e., observations) could cause underestimation in the case of target hardening as there is sometimes a deliberate effort to conceal objects. Similarly, measures implemented as the result of a burglary cannot be identified through this method. A survey of home owners could therefore complement the collected data. Fourth, for some measures, the interrater reliability was not very high and hence the number of preparatory field visits with the rating team could be increased. Finally, a larger sample size would enable the assessment of how combinations of environmental characteristics relate to day- and night-time burglary (i.e., interaction analysis).

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Note

1. Relative risk ratio is the ratio of the probability of a burglary occurring in an exposed group to the probability of a burglary occurring in a comparison, non-exposed group.

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