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Spatial and temporal communication of burglary risk

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Abstract

At the 5th and 6th International Space Syntax Symposium presentations were made about the results of two joint projects of the Technical University Delft and the Dutch consultancy firm RCM-advies. These presentations provided insight into the relationship between the geographic distribution of residential burglary and the influence of the spatial layout of the built environment. In the now proposed presentation, the findings of yet another project will be discussed. This project focuses on the spatial and temporal communication of burglary risk. The study does not only show that offences like residential burglary are clustered in space and time, but also that because of this clustering we are able to predict when and where crimes are likely to occur and act correspondingly.

The presentation tests the ubiquity of the above mentioned findings by analysing data about residential burglary in two Dutch cities. Is it true that crimes like residential burglary cluster in space and time? And, more importantly, is it prudent to label a burglarized home and its near vicinity as a potential hot spot and allocate crime reduction resources to this area? Research findings from outside the Netherlands suggest that such a (re)allocation of resources could help to prevent around 30% of all burglaries. The reports remain, however, unclear on what actions must be taken and how these must be organized.

Communication of risk

To answer the above mentioned questions, research was conducted in the Dutch cities Gouda and Alkmaar. The results of this study confirm that residential burglaries cluster in space and time. A large portion of the residential burglaries in Gouda and Alkmaar (66% resp. 74% of the total) is committed by burglars that are returning to the area within 1-30 days. Another significant part (15% resp. 10%) is committed by burglars who do not return but continue to burglarise homes in the given area. This last type of offender visits a certain area and commits his crimes wherever he thinks the spatial and physical conditions are favourable. In both cases, it is however likely that the burglaries are committed by the same offender or offender groups.

Spatial characteristics

There are some notable correlations between the different types of near repeats, and the spatial characteristics of the street segments. These correlations suggest that the burglar's decision to commit one or several burglaries is influenced by the segment's accessibility. Near repeats are most likely to occur in street segments that are relatively close to the main routes, well connected to adjacent streets and in dwellings that are relatively close to the street. Offenders that commit a single residential burglary are more inclined to choose less accessible dwellings than offenders that commit near repeat burglaries. They commit their burglaries more often in street segments that are located deep inside the neighbourhood and less well connected to adjacent streets. The dwellings of their choice are often further away from the street and surrounded by gardens, fences, and/or hedges.

Keywords

Crime, risk communication, permutation analysis, spatial characteristics.

1. Introduction

In 2001 a study was published by Frank Morgan in which he reported his findings on repeat victimization in a suburb of Perth (Australia). Morgan had discovered that repeat burglaries in some homes were followed by several other burglaries in the vicinity of that home. He called these burglaries 'near repeats' and argued that somehow they had to be related to the repeat burglaries that previously had been committed in the near vicinity. The 'near repeat' phenomenon is according to Morgan easy to explain and most probably related to the fact that a burglar or a group of burglars has been active in a certain neighbourhood during a certain time (Morgan 2001, p. 112).

The fact that 'near repeats' are more common than we may suspect has been confirmed two years later in another Australian study. Townsley et al. (2003) tested the hypotheses that residential burglary in a sense is 'contagious' and came to the conclusion that somehow this is indeed the case. Especially in neighbourhoods with a homogenous architecture, they found that residential burglaries are clustered in space and time. They describe this clustering by drawing parallels to the epidemiological sciences and call it the 'contagion process of victimization'. Near repeat victimization is according to them a special form of repeat victimization. In the case of repeat burglary, both crimes are committed within a relatively short timeframe in the same household. In the case of a near repeat both crimes are committed in the same neighbourhood. The fact that near repeat victimizations can especially be found in homogenous neighbourhoods is explained by the researchers by the vulnerability characteristics of the available houses. In neighbourhoods with heterogenic architecture, the number of attractive targets is limited and burglars will be inclined to concentrate their efforts on homes that they have successfully burglarised before. Homogenic neighbourhoods, however, have a lower variance of vulnerability characteristics and properties are therefore all as attractive to the burglars. Burgling one of those properties provides the offender detailed information on the internal layout and security weaknesses of the individual property as well as all other properties in the neighbourhood. The offender acquires knowledge on the accessibility, layout and escape routes not only from this property but from all similar houses in its vicinity. This knowledge is useful to burglarise similar properties and reduces the burglar's risks for detection.

At the same time as the Australian research, a similar study was conducted in the United Kingdom. This study confirmed that also residential burglaries in Merseyside (Liverpool and surroundings) show characteristics of risk communicability. Using statistical techniques to study the transmission of contagious diseases, the study showed that burglaries do cluster in space and time. The residential burglary flags the elevated risk of further residential burglaries in the first two months and in the proximity up to 300 – 400 meters (Johnson and Bowers 2004a; 2004b). Repeat victimization is more common in the deprived areas, whereas there is more evidence of near repeats in the more affluent parts of the city (Bowers and Johnson 2005).

Also in The Netherlands, there is a growing interest in risk communicability. Parallel to the study that is discussed in this paper, a research was carried out by Wim Bernasco. Bernasco (2007) shows that the contagion process of victimization is also evident in the Dutch cities Den Haag, Zoetermeer and Delft.

International comparative research shows that near repeat victimization is an ubiquitous phenomenon (Johnson et al. 2007). In Australia, Japan, New Zealand, the United Kingdom, the United States and the Netherlands evidence is found of space-time clustering of residential burglaries. However, the distance over which the risk of victimization appears to communicate varies across locations in both spatial and temporal dimensions. It is proposed that the communication of risk is influenced by the housing density, transportation infrastructure and the social, demographic and physical factors of the residential areas and this is indeed a plausible partial explanation for the differences in spatial variation. It is, however, unclear to what extent these factors are also affecting the temporal variations between the different countries.

Same offender(s)?

To what extent may we presume that near repeats are caused by the same offender(s) revisiting the same neighbourhood? There are two conceptual approaches that shed a different light on this question (Pease 1998; Bowers and Johnson 2005; Bernasco 2007). In some cases it is likely that the victimization risk of a certain property is increased as a direct result of the initial burglary. There is something about the initial offence that highlights the property as an attractive target for burglars. So the initial victimization boosts the chance of further victimization. It is, however, also suggested that it is possible that the targeting of a specific place or property is independent of the victimization history. The property or (in the case of near repeat) properties are victimized on a number of occasions – and possibly by several unrelated offenders – because the properties themselves have some notable security weaknesses or are known to provide interesting loot. In this case the first victimization merely flags an elevated risk. These two mechanisms are known as the boost- and flag-explanation. In the case of a boost-explanation it is likely that the repeats or near repeats are committed by the same offender(s). But when a vulnerable situation is merely flagged, this does not necessarily have to be the case.

The finding that risk communication is especially common in neighbourhoods with a homogenous architecture (Townsley a.o. 2003) seems to support the flag-explanation. Nevertheless, there is one convincing argument why in many cases a boost-explanation may be more favourable. The flag-explanation makes it plausible why two or more burglary offences are situated in close spatial proximity, but does not give an explanation for the temporal proximity. The clustering of offences in both space and time can only be explained when we presume a direct causal relationship between both offences. In this respect, it is often suggested that time-space clusters are often caused by the same offender or group of offenders returning to the crime site (Morgan 2001). The first crime provided the offender(s) some valuable learning experiences that can be used for the repeats. Also the fact that repeat victimization is especially common in deprived areas and near repeats in the richer parts of town (Bowers and Johnson 2005) gives support to this boost-explanation. In the deprived areas, residents do not have the same possibilities to take preventive measures than in the richer areas. They have far less financial resources and are more often renting their homes and therefore depend on the goodwill of their landlords. The repair of broken doors or windows generally takes much longer in the deprived areas. Returning burglars take advantage of this weakness and are so more inclined to target the same property rather than to burglarise one of the neighbouring homes. In the affluent areas, residents are commonly known to take swifter action. Broken and damaged doors, windows, locks and hinges are quickly repaired or replaced by the residents who often also own the property. In these cases, the chance on repeat victimization is lower. Returning burglars are less inclined to revisit the same property and more often prefer to try their luck in one of the neighbouring buildings. A last clue, that risk communication in many cases is related to returning offender (groups) can be found in the fact that near repeats are more likely to share the same modus operandi than non near repeats and this effect goes beyond the effects of space and time. Thus, while burglaries that occur in close spatial proximity are more likely to share the same modus operandi, they are even more likely to share the same modus operandi if they are also close in time (Bowers and Johnson 2004, p. 20). Everything considered, we must conclude that there is no compelling evidence that near repeats are committed by returning offenders or offender groups. There is, however, a body of circumstantial evidence that suggests that in many occasions near repeats are indeed committed by the same offender(s).

Research questions

Risk communication is a relatively new subject in environmental criminology. Recent studies have made it clear that residential burglaries are often clustered in space and time and that it is likely that this clustering in many cases is related to returning offenders. However, there are still a lot of unanswered questions.

This paper takes the existing studies on criminal risk communication as a starting point and tries to advance our insights on the subject by testing the ubiquity of the findings in two Dutch cities on a much smaller level of abstraction and with the use of both epidemiological and space syntax tools. This is a rather new approach to this subject.

To what extent is the risk of non-burglarised homes shaped or indexed by the first event? What are the exact time-intervals and what is the spatial range of these time-space clusters? How common are these near repeats, what are the spatial characteristics and to what extent may we presume that near repeats are caused by the same offender(s) revisiting the same neighbourhood? To answer these questions, the research needs to examine the extent to which residential burglaries cluster in space and time, and analyse the data in terms of days and meters rather than (as the previous studies did) months and intervals of 100 meter. Secondly, we need to bring space syntax techniques into the analyses as only these techniques can deliver us insight into the relationship between time-space clusters and the characteristics of the street net.

2. Data

For the study, spatial and temporal data from the Dutch cities of Gouda and Alkmaar were gathered. First of all, police records from registered residential burglaries in the period 2003 – 2005 were collected and stored in a database. Each offence record contained data on the date and time of the incident. Since it is not always clear when the actual offence took place, a distinction has been made between the earliest and latest date and time on which the offence – according to the reporter – could have happened. With respect to the location of the criminal incident, information on the exact address (street, house number, city) and X/Y-coordinates have been registered. Locations that contain too many households (student dormitories, houses for the elderly, hospitals, etc.), locations without valid X/Y-coordinates and properties that were clearly not residential were removed from the data set. With regards to the temporal aspect, all cases in which the difference between the earliest and latest possible offence date are bigger than one day were removed. In this way, two data sets were created that contain respectively 835 and 1,153 from the by the police in Alkmaar and Gouda registered burglaries (79% and 82% of the total). Both data sets were analysed separately, in order to answer the research questions more convincingly.

3. Statistical approach

The medical sciences have several methods to answer the question whether or not a disease is contagious. A disease is inferred to be communicable if people catch it soon after exposure to a disease agent. Communicability is thus inferred from closeness in space and time of manifestations of the disease in different people. Only a clustering in space or time is thus insufficient. Two criminal incidents are considered to be communicable if they do not only take place in each other's near proximity, but also within a short time interval. One statistical method to establish whether or not incidents are clustered in space and time is the so-called permutation test. This test measures the clustering of recorded incidents in space and time and then compares the observed distribution with that what would be expected on the basis of chance. In order to do so, the permutation test compares all cases (with the total number of N) with all others (N-1) making the total number of paired combinations N * N-1. By using previously defined threshold values (e.g. an Euclidean distance of 0 – 100 meters and temporal distance of 0 – 30 days), the test calculates the total number of paired combinations that fall within these thresholds (the observed number). The test also estimates the number of paired combinations that would be expected if the incidents were independent of time and space (the expected number). By dividing the observed number of paired combinations by the expected number, we establish the Knox ratio. This ratio shows if and to what degree incidents (within the defined thresholds) are clustered in space and time. If there is evidence of space-time clustering, the Knox ratio will be statistical significant ($p<.01$), having a value greater

than one. In these cases, the conclusion must be that the incidents are indeed related to each other ('contagious').

A permutation test is helpful to establish to what degree incidents are clustered in space and time, but does not identify which of the incidents are clustered. A distinction between clustered and non-clustered incidents is important if we want to gain insight in the statistical relationship between the incidents and the distribution of the various spatial, temporal and incident characteristics. To identify the clustered burglary pairs and save them in a separate data set, special software was developed and written by the author. This software starts with an Excel-list containing the geographic coordinates (X/Y-coordinates) of all recorded incidents as well as the date of the offences. The data of the two cities are put in two separate data sets and per data set all possible paired combinations are calculated. The software calculates the spatial and temporal distance for each paired combination. If both the spatial (Euclidean) and temporal distance of the combination is smaller than the predefined threshold, the paired combination is selected and saved in a separate list. Based on theoretical considerations and the results of the first analyses, two separate lists were constructed in which thresholds were used of respectively 0-1 day / 25-400 meters and 1-30 days / 25-400 meters. This way, insight was generated in three types of incidents: 1) near repeats that have occurred within 24 hours, 2) near repeats that occurred between 1 – 30 days, 3) pairs of residential burglaries that show no evidence of time-space clustering. The following is a mathematical description of method outlined above. We denote $(s_1,t_1),(s_2,t_2),...,(s_n,t_n)$ the locations and the times of the incidents. We construct all possible pair combinations that can be made from the set of these incidents. These are $\binom{n}{2}=\frac{n!}{2!(n-2)!}=\frac{n(n-1)}{2}$ pairs. For each pair (s_i,t_i) and (s_j,t_j) we compute $d_{ij}=\|s_j-s_i\|$ and $t_{ij}=|t_j-t_i|$ and we categorize the $\frac{n(n-1)}{2}$ pairs in the three categories:

1. near repeats that have occurred within 24 hours if $d_{ij}\in(25-400\text{ meters})$ and $t_{ij}\le 24\,hours$.
2. near repeats that occurred between 1 – 30 days if $d_{ij}\in(25-400\text{ meters})$ and $t_{ij}\le 30\,days$.
3. no evidence of time-space clustering if $d_{ij}\notin(25-400\text{ meters})$ or $t_{ij}\ge 30\,days$

In a previous study (presented at the 6th Space Syntax Symposium), micro-scale spatial data was gathered in two areas of Alkmaar and Gouda (López and Van Nes 2007). In this study, 1,168 street segments were visited and visual registrations were made of 25 spatial variables. Apart from these micro-scale variables, 9 macro scale spatial characteristics were calculated per street segment and data was added on the number, place and time of recorded burglary incidents. By adding these data to the data sets of paired burglary incidents, it became possible to relate the different 'repeat categories' to the spatial conditions of the street net.

4. Evidence of space-time clustering

Do residential burglaries in the Dutch cities of Alkmaar and Gouda cluster in space and time? Yes, there is evidence that indeed they do. The results of the first series of permutation tests (in which the same threshold values were used as in the studies in Australia and the United Kingdom; 1 month and 100 meters) show that relative to the pattern expected, residential burglaries in Alkmaar and Gouda are more likely to occur within close proximity of each other in terms of both space and time.

Table 1: Observed and expected burglary pairs related to various distances in space (in meters) and time (in days), Alkmaar 2003-2005, N=835

	0-30 days		30-60 days		60-90 days		90-120 days	
	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.
Repeats	61	39.0	33	37.2	30	35.7	32	33.9
0 - 100 m	109	68.3	59	65.1	72	62.6	46	59.3
100 – 200 m	246	191.8	189	182.7	183	175.8	157	166.6
200 – 300 m	332	290.0	278	276.2	255	265.8	263	251.9
300 – 400 m	433	379.6	372	361.5	333	347.8	309	329.7
400 – 500 m	463	432.1	470	411.6	437	396.0	379	375.4

Table 1 presents an overview of 835 residential burglaries that took place in 2003-2005 in Alkmaar and were recorder by the police. Of each of these incidents, paired combinations were made in which both the spatial and temporal distances were calculated of this specific incident related to all other recorded incidents. This resulted in 348.195 paired combinations. The table shows both the observed numbers as the values that can be expected if the incidents were independent of time and space. It shows e.g. that 109 burglary pairs were found to have occurred within a distance of 100 meters and 31 days, while based on chance we would expect a number of 68.3. The observed number divided by the expected number (the Knox ratio) is in this case 1.56, which confirms that the number of pairs falling into this category was significantly higher than would be expected on the basis of chance.

Table 2: Knox ratio's related to various distances in space (in meters) and time (in days), Alkmaar 2003-2005, N=835

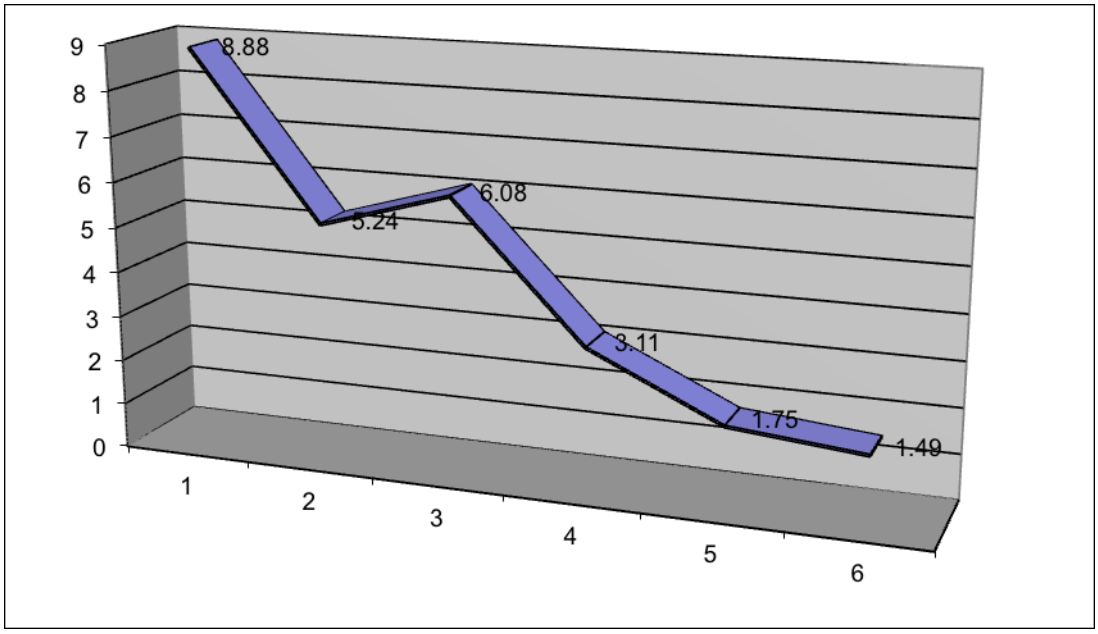
	0-30 days	30-60 days	60-90 days	90-120 days
Repeats	**1.56**	0.89	0.84	0.94
0 - 100 m	**1.60**	0.91	1.15	0.78
100 – 200 m	**1.28**	1.03	1.04	0.94
200 – 300 m	1.14	1.01	0.96	1.04
300 – 400 m	**1.14**	1.03	0.96	0.94
400 – 500 m	1.07	**1.14**	1.10	1.01

In Table 2 the Knox ratios are presented for every spatial and temporal combination. The ratios printed in bold, are statistically significant ($p<0.01$). The table shows that the recorded burglaries are indeed clustered in space and time. Especially in the first month and a range of 400 meters of the burgled home, the risk for near repeats is significantly elevated. The table does not only show the presence of time-space clustering, but also a sharp fall of risk elevation with the increase of spatial distance. In the month following the initial burglary, the risk for near repeat on a distance of 0-100 meters is 60% higher than would be expected on the basis of chance. On a distance of 300-400 meters, this elevated risk is however dropped to 14%. This finding is very much in line with the

results of previous studies. It is, however, interesting to see what will happen when we take threshold values that are a lot smaller than one month and 100 meters.

Because the data set of this study is set up in such a way that we know exactly on what day the recorded incidents took place and where it took place, it provides the possibility to study space-time clustering on much shorter distances. The data makes it possible to focus on much smaller analytical units and select thresholds of 25 meters, weeks and even days. When we zoom in to these finer dimensions and redo the analyses, we discover that risk communicability is especially common in the week following the initial burglary and within a range of 500 meters. In Alkmaar this is 145% higher than would be expected on the basis of chance and in Gouda 129%. When we shift our focus from weeks to days, it becomes clear that the largest number of near repeats take place in the first 24 hours. Apparently, the smaller the distance in time and space, the higher the risk on near repeat victimization.

Figure 1: Knox ratio's in the first 24 hours after the initial burglary related to different spatial distances (in categories of 50 meters). Alkmaar, 2003-2005, N=835



How can these findings be interpreted? Apparently, residential burglaries in both cities are clustered in space and time, but the theoretical explanation that this is largely caused by offenders who after some time return to the initial crime location has to be reconsidered. A large portion of the near repeats takes place within the first 24 hours. In these cases, it is still likely that the burglaries are committed by the same offender(s) but not offenders who after some time return to the crime location but offenders who continue to burglarise the neighbourhood. In other words: a large portion of the near repeats must be considered as serial offences that are committed by burglars who target one specific area in a given day or night.

5. Spatial characteristics

Part of the recorded residential burglaries took place in the neighbourhoods where one year earlier a space syntax study has been carried out (López and Van Nes 2007). For this study a large number of spatial data was collected for each of the 1,168 street segments. By merging the data sets of the

space syntax study with the sets of the current study, a new set of data was created that contains detailed information of the exact spatial conditions of 162 burglaries in Gouda and 165 burglaries in Alkmaar. That is respectively 17% and 20% of the total number of recorded burglaries in those cities. The relatively low number of incidents in this data set, limits the possibilities to make valid analyses on the relationship between time-space clusters and spatial characteristics on the level of the separate neighbourhoods. It is, however, possible to do a valid analyses on the complete data set (so all the observed neighbourhoods in Gouda and Alkmaar taken together). Such an analyses provides interesting new insights into the spatial nature of space-time clusters both with regards to the street segments as the way on which public and private spaces are connected.

Table 3: Three types of near repeats related to the mean depth and connectivity of the involved street segment (p= 0.014 & 0.001)

Near repeats		Topological Depth	Segment connectivity
< 24 hours	Mean	**1.54**	**4.51**
	N	35	35
1-30 days	Mean	**1.34**	**4.23**
	N	157	158
No near repeats	Mean	**1.93**	**3.67**
	N	43	43
Total	**Mean**	**1.48**	**4.17**
	N	**235**	**236**

Table 3 shows that residential burglaries that are not part of space-time clusters are on average more prevalent in street segments with higher topological depths (mean topological depth = 1.9). When the near repeat is following the initial burglary within 24 hours, the mean topological depth is 1.5 (ANOVA p=0.014)

Also connectivity plays a role (ANOVA p=0.001). Residential burglaries that are not part of space-time clusters are more often committed in street segments with fewer connections to their neighbouring streets. This is especially the case when the near repeat is committed within 24 hours.

Table 4: Three types of near repeats related to the mean depth of public and private space (p= 0.04 & 0.005)

Near repeats		Depth 1	Depth 2
< 24 hours	Mean	**.71**	**.31**
	N	35	35
1-30 days	Mean	**.74**	**.41**
	N	158	158
No near repeats	Mean	**1.42**	**.81**
	N	43	43
Total	**Mean**	**.86**	**.47**
	N	**236**	**236**

Residential burglaries that are not part of space-time clusters are more often committed in homes with entrances that are relatively far away from public space (table 4, ANOVA p=0.04 & p=0.005). Especially when the near repeat takes place within 24 hours, properties are chosen that are very close to the street.

6. Conclusions

Is residential burglary contagious?

We all know that criminal incidents are not spread by means of pathogenic agents such as germs or viruses. Nevertheless the results of this analyses shows that (as in other countries and locations) burglary risks in Alkmaar and Gouda are to some degree communicable. Especially during the first month and in a range of 400 meters from the initial burglary, homes show an elevated risk on residential burglary. This elevated risk is not only significant, but also increases fast with the reduction of spatial and temporal distance. Until now risk communication was explained by the assumption that after some time offenders return to the location or area where they have previously successfully committed their crimes. The results of this study suggest that this explanation is indeed plausible for a large portion of the near repeats, but also that a considerable portion of these near repeats are not committed by returning but by continuing serial offenders.

How common are near repeats?

For this study, special software was written by the author that allows us to actually identify and count the number of near repeats in a certain area. When we do count the number of near repeats and separate the burglary pairs that occurred within 24 hours (presumably committed by continuing offenders), within 1-30 days (presumably committed by returning offenders) and cases that do not appear to be clustered in time and space, we notice that in Gouda 66% of all recorded burglaries are part of burglary pairs that occurred within 1-30 days, 15% are part of pairs that occurred within 24 hours and 19% of the burglaries are unrelated. In Alkmaar similar percentages are found, as 64% are presumably committed by returning offenders, 10% by continuing offenders and 26% show no spatial and temporal relationship with other burglaries.

Spatial characteristics

Is there a relationship between near repeats and the spatial conditions of places? Are there – in other words – differences in the spatial conditions of burglary incidents that can be defined as near repeats as compared to burglaries that are not near repeats? And is it possible to make a further distinction between near repeats that have been committed within 24 hours and near repeats that happened after 1-30 days? Until now, these question have not yet been explored, but they are nonetheless important for our understanding of space-time clusters.

Residential burglaries that are not part of space-time clusters are on average more prevalent in street segments with higher topological depths. Also connectivity seems to play a role as near repeats tend to be more common in street segments with a higher connectivity. A high number of entrance and escape routes especially seems to boost near repeats that are committed within 24 hours. These types of near repeats are also more often committed in homes that are relatively close to the public road. It is argued that the burglar's choice of one property over another is shaped by his personal estimation of accessibility, loot and guardianship (Bennett and Wright 1984; Cornish and Clarke 1986). If this assumption is indeed true, we can conclude that accessibility is important to all three categories of burglary but even more so when the burglary is a near repeat. Burglars who visit one home to commit a single burglary are apparently less repelled by the inaccessibility of the

property than burglars who target several homes within a certain neighbourhood. Those burglars generally more often commit their offences in the street segments that have a high topological depth (so they are located far from the main routes, more towards the centre of the neighbourhood) and a relatively limited number of access and escape routes (lower accessibility). Burglars who commit several offences in a single area or neighbourhood are more often targeting homes that are close to the street, nearer to the main routes and situated in highly connected street segments.

Burglars

It has been assumed that near repeats are often committed by offenders who revisit the same neighbourhood and the same type of properties. The results of this study suggest that indeed a large portion of the residential burglaries in Gouda and Alkmaar (66% resp. 74% of the total) is committed by returning burglars, but also that another significant part (15% resp. 10%) is committed by burglars who do not return but continue to burglarise homes in the given area. This last type of offender visits a certain area and commits his crimes wherever he thinks the spatial and physical conditions are favourable. In both cases, it is however likely that the burglaries are committed by the same offender or offender groups.

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