HOUSING LAYOUT AND CRIME VULNERABILITY

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0 Abstract

Much research from different disciplines has explored the crime-space relationship often with controversial results. By employing the "Space Syntax" analysis, this research proposes to examine the relation between on the one hand spatial layouts of housing estates and urban areas and on the other hand spatial distribution of property offences, based on crime reports provided by the police, to see how far a definite and consistent relationship can be established. A major concern would be the issue of the accessibility of housing layout (spatial configuration of open spaces) and the relative vulnerability of property crimes, such as burglary, criminal damage (vandalism) and car crimes. Case-studies cover a wide range of social classes, such as middle-high, middle-working and working class housing estates, and were carefully examined for a period of one year. The findings from this research provide empirical evidence for scepticism on the idea of "territoriality" and "defensible space" put forward by Oscar Newman (Newman, 1972), and suggest that, other things being equal, property crimes tend to cluster in those globally or locally segregated areas, particularly in cul-de-sac footpaths and rear dead end alleys, but also in those segregated short cul-de-sac carriageways which Newman considered to be the key to increase local surveillance and hence to exclude casual intrusion by non-residents. Positive features which make spaces safer are integrated through roads with front entrances on both sides, exactly those anonymous spaces Newman considers more prone to crime.

1 Intention and Focus

The issue of space and crime has been dominated by Oscar Newman's ideas of defensible space despite the fact that findings by other researchers, among whom the Space Syntax Laboratory as evidenced in Against Enclosure (Hillier, 1988: pp. 63-88), have provided evidence against Newman's position. This paper, through an extended body of evidence, will discuss various distinctive elements which make a space safer and compare them to the suggestions made by Oscar Newman. By employing the space syntax method for spatial configuration analysis of housing layouts and cross examining typological and syntactic variables and their relationships with different types of crime rate according to the exact location and most importantly the break-in point of the targeted dwellings, this research yields empirical evidence to clarify the correlation between the spatial properties of housing layouts and the distribution patterns of different kinds of property crimes, such as burglary in dwelling, criminal damage and car crimes of all kinds. Due to the length limit, this paper can only focus on residential burglary, which seems to be the most problematic and im-

portant one.

Case studies are based on three socio-economically distinctive towns, all in England but outside London. In each town one residential area with a clear boundary has been chosen for detailed analysis. Due to the crime data protection act restriction, these three studied areas have to be described in an anonymous way, and were labelled town A, a middle of the road area in a new town, town B, a largely up-market area, though with down-market pockets in a largely more affluent town, and town C, a mixed area in a generally less affluent town, respectively. The three selected housing areas not only include a wide range of different social classes but also cover many spatial patterns, such as through carriageway complex, cul-de-sac carriageway complex, etc. Unlike other previous researches, which often tackled the crime-space issue by showing the general crime rate of one area as a whole or by expressing the unspecific crime rate per dwelling of each sub-area within the whole system, this research proposes to study the crime-space relationship by looking at the exact point of entry off the public space where offenders enter the private property. It is hoped that through these case studies the various assumptions and different viewpoints on this issue can be clarified.

2 Space as independent determining factor

The causes of crime in urban space, particularly in housing estates, are also related to social factors and not only to spatial factors. One often finds that badly designed housing estates (spatial factor) associate with poor social group of dwellers (social factor). This bureaucratic policy often has devastating results for crime in a particular area, while at the same time making the influence of the spatial factor unclear (Hillier, 1996:183). The problem to address is: How can one be sure that the space has an independent influence, apart from others, on patterns of crime? To deal with this question, one has to widen the research scope to cover various housing estates with different social groups (income level, education level, ethnic group). Only if, after examining estates with different social classes from different regions or towns, one finds that certain kinds of spatial patterns which commonly appear in those various estates have a relatively higher proportion of crime, then one can be sure that certain kinds of spatial properties do play an independent role for determining the clustering pattern of crime.

3 General problematic issues

One inevitable problem for research on the crime-space issue is the difficulty of finding out the real amount of crime. The issue of reported crime versus real crime is problematical since for most crime categories the number of real crime is higher than the number of reported crime as people do not always report crimes (Davidson, 1981: pp. 20-21). Trying to establish more precise crime data through interviews and questionnaires is fraught with difficulty since people may not provide correct information due to its sensitive nature. I decided to only use the reported crime figures to analyse the relationship between space and crime as they are the closest possible figures to real crime. This research makes use of reported crime records provided by police departments of three towns. In general it is quite hard to obtain crime data

because of their confidential nature, and it is even harder if the exact break-in point, essential for this research, is needed. Three areas in three towns were selected for this research and each reflects a different social level, so as to be able to restrict the influence of the social factor and to detect the independent influence of the spatial factor. The police departments of these three towns co-operated fully for which I am extremely grateful.

Studies of the crime-space problem by area in general terms, such as the Poyner & Webb study (Poyner & Webb, 1991), do not make clear to which particular spatial factors crimes can be attributed. Poyner and Webb cannot attribute the crimes to a particular type of road (spatial feature) as the exact point of entry is unknown. As a result, they can only tell which area has more crime and give us the general spatial features of that area. The crime itself cannot be attributed to cul-de-sac carriageway or through road as that information is missing. The break-in point records and the offender's method of operation, indicating from which part of the public space the offender accessed the exterior boundary of the target dwelling, could be obtained for this research and thus the exact location of the individual crime is known, as a result it is necessary to try and study the crime-space issue at this detailed level: the individual crime spot and its specific spatial properties. Therefore, the layouts and their relevant spatial characteristics should be described in an as precise and accurate way as possible.

4 Forms of analysis and methodology

Two major forms of analysis are used: one is space analysis, the other is space-crime analysis. For the spatial analysis two variables are used, namely typological variables and syntactic variables. Typological variables are characteristics of space and space use and the six major ones in this study are through carriageway, cul-de-sac carriageway, cul-de-sac driveway, through footpath, cul-de-sac front footpath, and rear dead end footpath. Housing layouts can be described in function of these six major spatial elements. There are three other important typological variables: constituted vs unconstituted, distributed vs non-distributed, and number of line neighbours. The distinction between 'constituted' and 'unconstituted' is defined as follows: if a space has more than 75% of its adjacent dwellings front facing onto the space then it is called constituted (and this means that the space has more or less continuous entrances on both sides), in all other cases a space is unconstituted. The distinction between 'distributed' and 'non-distributed' signifies that a distributed space is part of a pedestrian through movement system, while non-distributed means that it is part of a cul-de-sac complex where the only way out is to return on your steps. A third element considered in the analysis is the number of 'line neighbours' on a line, which means the number of other points of entry to dwellings along a particular line. If combined with 'constituted' then most of these will be front entrances.

Syntactic variables represent the degree of accessibility to the whole spatial system of each typological variable (six spatial elements). Here all spaces open to pedestrians within the research area are represented by a set of fewest and longest lines of sight, in which we call each sight line an axial line, and every axial line belongs to one of the six typological variables described above. Measures of syntactic property for

each line within the system are global integration (Rn), local integration (R3), and connectivity (CN). The global integration Rn "measures the degree to which each line in the map is present on the simplest (fewest changes of direction) routes to and from all other lines" (Penn, 1994:appendix D). The scope for measuring integration may only involve the local system, for example, the measure of R3 represents the degree of local accessibility of each line, which only involves three steps from each axial line within the local system. The third measure is called connectivity (CN), which indicates the number of neighbouring axial lines.

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A study area is always part of a larger urban system and the question poses itself as to how large the scope of the axial map should be for optimum results. From many researches carried out by the Unit for Architectural Studies in the Bartlett School of Graduate Studies at University College London, it became clear that the measure of integration Rn embedded in the whole urban system can be the best predictor for pedestrian and vehicular movement (Hillier, 1989). Therefore, in these case studies embedded system is used for syntactic analysis. Since burglars in general avoid being seen and prefer areas where there are fewer people passing through, the Space Syntax method seems to be particularly suited to crime-space analysis.

For the space-crime analysis two types of study are proposed: first, the relationship of crime patterns to individual variables, i.e. typological and syntactic ones, and secondly, the crime patterns in relation to combined sets of variables, both typological and syntactic variables mixed: typo-syntactic variables. The crime-space analysis in this research is not based on dwelling, but instead on the point of entry off the public space which is the basic unit of the analysis. The crime data provided by the police which record the exact break-in point to the dwelling (front window, back door, etc.) and the point of entry from public space to private space through the method of operation description (over rear fence, through front garden, etc.) were combined to plot the crime spots on the map. The dots on the map represent the point of access into the dwelling, whereas the little tail links the break-in points to the access from the public space. Where exact information of the method of operation description is missing in the crime data the most plausible reconstruction of a burglar's action is used. This is considered the most precise form of analysis which takes into account all possibilities. An example will make this clear: if a house is on a through road but is burgled through rear access, for instance a dead end footpath, then the burglary counts for the rear dead end footpath and not for the through road. It is without doubt that burglars try to find the point of entry, both to the dwelling and off the public space, with least resistance.

The lines of the axial maps are used as units of analysis in the data table on which the analysis below is based. Lines can be quite short or very long and consequently it is not advisable to use rates per line as study method, because the longer a line is the more dwellings and points of entry will be located on it. Shorter lines with fewer dwellings will seem to have high crime rates whereas longer lines with more dwellings will seem safer. This is obviously a kind of artificial result and does not illuminate the crime-space relationship. Instead, I intend to use each type of line with whatever set of added properties is appropriate, both typological and syntactic vari-

ables will be looked at individually and in combination. Then I simply total the number of points of entry adjacent to public spaces for lines of that particular type and with those particular properties and compare them to the total numbers of burglaries on those lines by dividing the latter into the former. In this way, a rate for crime can be calculated for each type of line across all three areas expressed in a fraction of one out of how many points of entry are offended against. All of the variables and their interrelationships can be studied in this way for the degree of vulnerability to crime for whichever area is considered necessary, in this paper the three areas combined.

5 Description of case studies

The three areas studied are called Town A, Town B and Town C. They have been studied for a one year period (1994-1995) during which 213 burglaries, 305 car crimes of all types, and 66 cases of vandalism were distributed amongst 3548 dwellings with 5834 points of entry. These are distributed on 849 lines, of which 9% are through roads with 25% of the points of entry, 40% are cul-de-sac carriageways with 47% of the points of entry, 11% are cul-de-sac footpaths with 7% of the points of entry, 23% are through footpaths with 17% of the points of entry. The remainder are various combinations and special cases. The average of non front burglaries is 69% for the three areas combined, with 81% in Town C, 60% in Town B and 62% in Town A. In all following tables, burglary rates will be for points of entry off public spaces, unless otherwise stated. In Table 1 the rates of crime per point of entry in each area as a whole are given first and the rates of crime per dwelling are shown in parentheses:

TABLE 1

	burglary	car crime	vandalism
Town A	1/29 (1/17)	1/20 (1/12)	1/103 (1/59)
Town B	1/48 (1/29)	1/26 (1/16)	1/79 (1/49)
Town C	1/17 (1/11)	1/13 (1/9)	1/86 (1/55)

Looking at point of entry and at dwelling it is clear that the burglary and car crime rates are the lowest for Town B which is known as posh town, whereas the burglary and car crime rates are the worst for Town C which is less affluent than Town B. Burglary rates are nearly three times as high in Town C than in Town B, and car crime two times as high in Town C. Car crime has the highest proportion of these three types of crime in all three areas. The patterns of burglary and car crime show the same tendency, vandalism , however, is different.

5.1 Town A

This town uses the super grid style layout, i.e. main roads separate from the estates, and thus the study area in this town is blocked off on all sides by main super grid through roads except for the west side where there is open park land and a railway line with footbridge. The western area, which is globally segregated, has a high concentration of burglary (see Figure 1 for layout, Figure 2 for axial map with lighter shaded lines more segregated). An especially strong concentration of burglary (7 cases) can be detected in a globally and locally segregated cul-de-sac near the western edge. Also in the west, a line of houses with front doors facing onto a through footpath, with rear cul-de-sac carriageway functioning as parking space, which is

globally segregated and locally broken up, is also extremely vulnerable to burglary. It seems that there is a tendency for burglary to occur on those globally segregated and locally broken up spaces. Clearly, there is a multiple effect on burglary rates which is the outcome of the combined attributes of both global and local factors. It is obvious that the two linear through carriageways, one in the north and one in the south of the estate, which are also for the most part 'constituted', are burglary free. Through carriageways are relatively safe spaces in this area, whereas cul-de-sac carriageways are more vulnerable. Through footpaths, however, are the most prone to burglary in this estate. One tendency which can also be noticed from this case study is that houses at corners seem to become preferred targets over others. Also burglary free are two long linear constituted cul-de-sac carriageways off integrated through roads in the north of the estate.

5.2 Town B

In this town, the study area is a richer area with a small industrial complex in the centre and a commercial area in the north east. The south and east sides are dominated by big houses, some of which have long driveways. More modest housing can be found in the central area and a poorer housing complex is situated to the north west. A footpath complex in the less affluent north west area connects a tree-like vehicle layout, but elsewhere there are hardly any footpaths except for a narrow north south footpath in the centre. Burglaries cluster in the poorer north west sub-area, which is also the most globally segregated area (see Figure 3 for layout, Figure 4 for axial map). Again this particular sub-area is spatially far more broken up than other sub-areas, and it is characterised by through footpaths connecting to a tree-pattern cul-de-sac layout. This kind of spatial layout is equally vulnerable as the similar layout in Town A area. Burglaries in the more spatially integrated richer sub-areas seem to take place either at the end of short cul-de-sacs, or from off the through carriageway spaces such as small cul-de-sacs and long driveways to individual houses, both providing cover for burglars through concealing bushes. Again, an obvious tendency for burglaries not to occur on longer linear through carriageways, such as the spatially integrated through route from south west to north east which also has continuous double facing entrances (i.e. constituted) and exceptionally good linear intervisibility, without concealing bushes, can be observed. Again, as in Town A, a burglary free tendency can also be detected in those long linear constituted cul-de-sac carriageways just off integrated through streets in the west and the south areas.

5.3 Town C

This town is characterised by peripheral through streets which embrace a tree like pattern of cul-de-sac carriageways linked by a complex system of footpaths. A very strong concentration of burglary can be noticed in the south east area, for the larger part concentrated in two cul-de-sacs, which are mostly burgled through access from either the rear through or the rear dead end footpaths. In the south west area there is a long linear constituted cul-de-sac carriageway in a globally extremely segregated area with partly no back access where all break-in points are located in the front. The extreme segregation facilitates burglary from the front. Constitutedness and no back access are not enough to protect cul-de-sac carriageways, integration is also necessary. The north west and north east areas which are highly broken up, spatially segregated (see Figure 5 for layout and Figure 6 for axial map) and made up of vehicular

cul-de-sacs linked by footpaths are also vulnerable to burglary. Constituted through carriageways on the south border record hardly any crime. The tendency for linear through carriageways to be low on burglary can again be observed. It is obvious from looking at the crime distribution map that rear footpaths, both through and dead end, offer the greatest vulnerability for burglary.

Again long linear constituted cul-de-sac carriageways just off integrated through roads are burglary free, just as in Town A and Town B. It seems from these data that long linear constituted cul-de-sac carriageways are protected from burglary by being close to integrated through carriageways.

6 Typological variables vs burglary rate

This section will focus on each typological variable on its own and consider its effect on crime rates, whereas the next section (section 7) will discuss the effect of syntactic variables and section 8 will regard variables in combination. Single properties, typological or syntactic, are not the determining factors for housing layouts and crime, rather the combination of these properties in different types of space determines vulnerability. The results from this simple typological comparison across all three areas are shown in the following table:

TABLE 2

spatial types	constituted	unconstituted	all
all carriageways	1/55	1/32	1/40
through-carriageways	1/148	1/46	1/70
cul-de-sac carriageways	1/39	1/29	1/32
all non-carriageways	(see note 1)	1/15	1/15
cul-de-sac driveways	—	1/11	1/11
through footpaths	—	1/22	1/22
cul-de-sac front footpaths	(see note 1)	1/18	1/22
rear dead end footpaths	—	1/8	1/8

note 1: There are no burglaries on constituted cul-de-sac front footpaths where there are only 28 points of entry in total.
note 2: To understand this table, figures should be interpreted as follows: a rate of 1/39 means that for every 39 points of entry on a particular spatial type one point was burgled during the one year period of study.

Comparing all carriageways to all non-carriageways, i.e. pedestrian access routes, shows clearly that the carriageways (1/40) are more than twice as safe as the pedestrian access routes (1/15). Within the group of all carriageways a distinction is made between through carriageways and cul-de-sac carriageways. The results indicate that through carriageways (1/70) are more than twice as safe as cul-de-sac carriageways (1/32). In general, regardless of the factor constitutedness or unconstitutedness, the most vulnerable spaces are first the rear dead end footpaths and next the cul-de-sac driveways. Vulnerability decreases with cul-de-sac front footpaths and through footpaths which are equally vulnerable. Then follow cul-de-sac carriageways, with finally through carriageways being the safest spaces in the system.

Specifically studying the typological factor of constitutedness versus unconstitutedness for through carriageways shows that constituted ones (1/148) are three times as safe as unconstituted ones (1/46), the general burglary rate for through carriageways being 1/70. Similarly for constituted cul-de-sac carriageways the burglary rate is 1/39, but for unconstituted ones it is 1/29. Though the difference between constitutedness and unconstitutedness is not as marked as it is for through carriageways, still constituted cul-de-sac carriageways are safer than unconstituted ones.

Another typological factor is distributedness versus non-distributedness. It is obvious from the data that you are safer in through complexes than in non-through complexes. In through complexes, which are obviously distributed, the burglary rate is 1/37, whereas for non-through complexes, which are non-distributed and where you have to return on your footsteps to leave the area, it is 1/17. Cul-de-sacs are not necessarily non-distributed and thus for front cul-de-sacs with interconnections to through footpaths, i.e. distributed ones, the burglary rate is 1/37, whereas for pure front cul-de-sacs, non-distributed, the rate is 1/ 22, exactly as vulnerable as through footpaths.

A further factor to discuss is the influence on the burglary rate of the 'number of line neighbours' a dwelling has, with line neighbours referring to the number of other points of entry to dwellings that can see yours. Lines with more than the average number of 'line neighbours' (i.e. more than 8) have a burglary rate of 1/37, whereas for those with fewer than the average number of 'line neighbours' (i.e. fewer than 8) it is 1/17. More line neighbours seem to protect dwellings more from burglary. Breaking these data down for through carriageways shows similar results: 1/76 for more line neighbours, 1/55 for fewer line neighbours. For front cul-de-sacs the same tendency can be observed: 1/40 for more line neighbours, 1/15 for fewer.

7 Syntactic variables vs burglary rate

The effect of the following syntactic variables, global integration, local integration and connectivity, on burglary rates is represented in Table 3:

TABLE 3

syntactic property	higher value	lower value
global integration (Rn)	1/47	1/17
local integration (R3)	1/41	1/16
connectivity (CN)	1/41	1/16

note: higher value means that only lines over the mean value of the total group (for Rn, R3, CN respectively) were selected, for lower value lines under the mean value. From this table it is clear that more globally integrated lines of all kinds with more potential movement have a lower burglary rate (1/47) than the more globally segregated lines which have less potential movement (1/17). These figures demonstrate that globally integrated lines are three times as safe as globally segregated ones. On the local level, more integration corresponds to a burglary rate of 1/41, which is more than two times better than the burglary rate for more segregated lines which is 1/16. Again, more connectivity proves to be safer as more connected lines have a rate of 1/41 and less connected ones a rate of 1/16. Just as was the case for typological variables, the results from these syntactic variables show that syntactic effects on burglary rates are marked. Therefore they should be considered as general background factors for crime rates, which work together with typological variables in different combinations. In a next step (section 8), both syntactic and typological variables will be combined to study their joint effects on burglary rates.

8 Joint effects of typo-syntactic variables on burglary rate

The final step of this crime-space analysis is to see whether there are significant influences on burglary rate from various different combinations of the typological and syntactic variables. Results of these joint effects from the typo-syntactic variables are to be found in table 4.

TABLE 4

typological variables	syntactic variables (Rn)					
spatial types	more integrated		less integrated		all	
through carriageways		1/91		1/57		1/70
constituted	1/167		1/135		1/148	
unconstituted		1/61		1/37		1/46
more line neighbours		1/172		1/52		1/76
fewer line neighbours		1/110		1/26		1/55
cul-de-sac carriageways		1/41		1/27		1/32
constituted	1/57		1/30		1/39	
unconstituted		1/34		1/25		1/29
more line neighbours		1/54		1/31		1/40
fewer line neighbours		1/23		1/20		1/21

In this section, I will first focus my attention on the two main types of carriageway (through vs cul-de-sac) in relation to global integration (Rn). Secondly the influence of integration vs segregation will be discussed for each type and finally this study will discuss the four safest and the four most vulnerable types of spaces for the two main types of carriageway combined with constitutedness or unconstitutedness and more or fewer line neighbours. In the first instance, the safest areas are found in the through

carriageways which are more integrated than average and have a rate of 1/91. Less safe are the through carriageways which are more segregated than average and this rate stands at 1/57. Decreasing safety can be found in the next group: the cul-de-sac carriageways which are more integrated than average have a burglary rate of 1/41. The most vulnerable type is found in cul-de-sac carriageways with more segregation than average where burglary rates stand at 1/27. Moreover, combined with the effects from constitutedness and line neighbours, this general picture will now be expanded and studied in more detail.

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Studying the influence of integration versus segregation one can note that for all typological variables more integrated areas are performing better than segregated ones. Sometimes that difference is quite extreme: For through carriageways with more line neighbours, integrated ones have a burglary rate of 1/172 whereas segregated ones have a rate of 1/52. In other cases the difference is much smaller, but is nevertheless there: For cul-de-sacs with fewer line neighbours, integrated lines have a burglary rate of 1/23 against 1/20 for segregated ones. For cul-de-sac carriageways with fewer line neighbours the positive influence of integration is limited. This means that short cul-de-sac carriageways with fewer neighbours are not safe areas. For cul-de-sac carriageways with more line neighbours the positive effect of more integration is clearly noticeable. So, long integrated linear cul-de-sac carriageways with more line neighbours, which look similar to long linear through carriageways, are safer. This explains why there are very few burglaries in the constituted long linear cul-de-sac carriageways just off integrated through roads as noted in the description of Town A, B and C.

Taking both constitutedness/unconstitutedness and more or fewer line neighbours into account with integration/segregation for the two main types of through carriageways and cul-de-sac carriageways is the next part of the analysis which I believe shows the clearest picture of the joint effects of typo-syntactic variables on burglary. The safest and thus least vulnerable spaces are all through carriageways. First in line are the through carriageways which are integrated and have more line neighbours, with a rate of 1/172. Following this are through carriageways which are constituted and integrated (1/167). Both these types have a very close degree of safety and can be called equally safe. The next safest spaces are through carriageways which are less integrated but constituted (1/135). There is only a minor influence noticeable between integrated and less integrated constituted through carriageways. The influence of integration or segregation on the constituted through carriageway is negligible, both are safe. The next category is less safe: a rate of 1/110 for through carriageways which have fewer than average number of line neighbours but are integrated. Still, this type is rather safe compared to what follows later on. So far certain types of through carriageways take up the least vulnerable position, especially constitutedness , more line neighbours and more global integration are the key factors to this safety. In between the safest and the most vulnerable groups one can see that different factors play a role for vulnerability on different types of roads (see Table 4 for details). The groups with the highest vulnerability include: segregated through roads with fewer line neighbours (1/26), segregated unconstituted cul-de-sac carriageways (1/25), integrated cul-de-sac carriageways with fewer line neighbours (1/23) and finally segregated cul-de-sac carriageways with fewer line neighbours (1/20). For cul-de-sac carriageways and through carriageways combined the highest vulnerability is domi-

nated by cul-de-sac carriageways. Segregation, unconstitutedness and fewer line neighbours are major factors in their vulnerability, and the worst case of all types is segregated cul-de-sac carriageway with fewer line neighbours.

Overall, comparing through carriageways to cul-de-sac carriageways, it can be noted that for the same combination of typological and syntactic variables through carriageways are always safer than cul-de-sac carriageways. This difference is more pronounced for the positive features of integration, constitutedness, and more line neighbours with through carriageways showing rates which are three times better than cul-de-sac carriageways in the same categories.

9 Conclusion

The data analysis above shows a clear picture of vulnerability. Bringing all these elements together it is possible to say that positive features of layouts are especially constitutedness, more global integration, more line neighbours (meaning linearity) and through networks (through carriageways). Negative effects can be noted from the following elements: unconstitutedness, global segregation, fewer line neighbours, and cul-de-sac networks, formed by cul-de-sac carriageways. The combination of unconstitutedness, segregation and fewer line neighbours (short lines) leads to spaces which are spatially broken-up and hence very vulnerable. A similar kind of vulnerability can be observed for cul-de-sac driveways and through footpaths, but the worst effect on burglary rates can definitely be attributed to rear dead-end footpaths.

For cul-de-sac carriageways integration, constitutedness and more line neighbours are all positive effects. This means that if long linear cul-de-sac carriageways with many front entrances of line neighbours facing each other are situated off integrated through streets, then they will also have lower vulnerability though not be as excellent as the through carriageways with these characteristics. It seems that burglars avoid dwellings on linear constituted through carriageways and also on the first line into the cul-de-sacs off integrated through streets, and instead look for those in the deeper, most segregated and also more broken up parts of the tree pattern like cul-de-sac complex, especially those with unconstituted back access.

From the above study it is obvious that the evidence shows that the ideas of 'defensible space' and 'territoriality' advocated by Oscar Newman should be regarded with more caution. Fewer line neighbours, segregation and cul-de-sac patterns are the qualities Newman stresses in his design theory to exclude the intrusion of strangers in the space, yet these qualities are the ones that make spaces quite vulnerable. Further case studies need to be carried out to obtain an even clearer picture of the relationship between crime and space.

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