Encounter and death

The spatial behavior of US serial killers

Maurice Godwin and David Canter
The University of Liverpool, Liverpool, UK

For the years 1986-90, the average number of murders reported in the USA annually, according to the Uniform Crime Reports, was over 20,000. Of these 20,000 murders, an average of about 5,000 are classified as unsolved each year (US Department of Justice, 1991). Furthermore, so-called stranger murders account for an average of 15 percent of all murders reported in the USA each year (US Department of Justice, 1991). It is suspected that many of these stranger-related murders are committed by episodic, sequential murderers, often referred to as "serial killers" (Hickey, 1991). In addition to the significant loss of life, which may be attributed to a few individuals who commit a number of murders, there are indications that since the 1970s there has been a distinct increase in serial killings, even after taking better reporting methods into account (Canter *et al.*, 1996; *Newsweek*, 1994; Stote and Standing, 1995).

As Jenkins (1993) has emphasized, the increasing impact of serial killers is likely to be a product both of the actions of individuals and the ability of law enforcement and other agencies to respond to those actions. He states that "no amount of aggressive or destructive behavior can result in a career of murder lasting months or years unless a number of other factors are present that create a victim population and a weak or confused law-enforcement response" (Jenkins, 1993, p. 463). As a consequence, a fuller understanding of serial killing has both academic merit as well as facilitating more effective law enforcement.

Serial killers present a particularly challenging problem for investigators because they generally murder strangers (Rogers *et al.*, 1991). Once their activities are established they are likely to become more skillful and as Holmes and DeBurger (1988) and Holmes and Holmes (1996) stress, it is consequently important to have early identification of such killers to afford control by police. Skogan and Antunes (1979, p. 217) have asserted that "the availability and reliability of information about incidents and offenders plays a key role in determining the ability of the police to solve crimes and apprehend offenders."

It has been established that there is a relationship between solving homicides and having information about a number of important locations. A recent study on the factors that contributed to solving serial murder investigations found that time and distance proved significant, suggesting that the more information on "the location of the original contact between the victim and the killer, where the assault occurred, the murder site, and the body recovery site the more likely a murder case will be solved" (Keppel and Weis, 1994, p. 386). Yet despite the importance of their locations, and the great cost of extended police

Policing: An International Journal of Police Strategy and Management, Vol. 20 No. 1, 1997, pp. 24-38.

investigations, the detailed consideration of offense locations and why they may be important are rarely researched. A few anecdotal illustrations are recorded by retired agents from the FBI Behavioral Science Unit when they write their memoirs (Douglas and Olshaker, 1996; Ressler and Shachtman, 1992), acknowledging that the distance the offender travels is an important factor in the solving of serial murder investigations; however, these have not been related to empirical studies testing hypotheses about the distances serial killers travel to carry various crime related activities. Consequently, an understanding of the processes that shape serial killers' journeys to crime has not been developed.

One notable exception has been the work of Rossmo (1993, 1995, 1996). Calling his approach criminal geographical targeting (CGT), Rossmo has combined concepts from environmental criminology with a mathematical model, based on a distance decay function, derived from the locations in which killers leave their victims' bodies, to indicate the area in which a serial killer may be living. Although Rossmo has not published any studies demonstrating the nature of the validity of his algorithms nor how they compare with other approaches he has provided illustrations of the utility of his technique.

The psychological principles on which Rossmo's work is based are not articulated in any detail but appear to derive from the postulate propounded by Brantingham and Brantingham (1981, p. 32) who suggest that victims are "probably spatially biased toward the offender's home base," illustrated by a study in Washington, DC that found that offenders in general victimize areas they know best, concentrating on targets within their immediate environments and surrounding areas (Brantingham and Brantingham, 1981, p. 178). This bias is the proposed cause of a decay function such that the further an offender is from home the less likely he is to commit an offense.

The reasons for the proposed decay are not exactly clear but are usually presented in relation to the least-effort principle. This postulates that when multiple destinations of equal desirability are available, all else being equal, the closest one will be chosen (Zipf, 1950). However, it is usually modified by two further considerations. One is supported most readily by Pettiway's (1982) results which found that specialist selectivity is reflected in the effort an offender puts into planning a crime. This leads to more selective and more carefully planned crimes being committed further away from home. This has been supported by comparisons across different types of crime in which it has been shown that the apparently more impulsive crimes of rape are committed nearer to home than robbery (Pyle, 1974) and that armed robbers travel further on average than those who are not armed (Capone and Nicholas, 1975, 1976) and tend to net larger sums of money. However, such considerations have not been included in Rossmo's computerized predictions of serial killers' residential location.

Another principle, incorporated into Rossmo's algorithm, and put forward as a basis for crime locations, is that there will be a tendency for offenders to avoid committing crimes close to where they live, often referred to as a "buffer zone" (Brantingham and Brantingham, 1981, 1984). The proposed reason for this is to

avoid leaving incriminating evidence near to where they live. However, the evidence for this is sparse. Davies and Dale (1995), for example, find no evidence for it in their limited study of single rapists. Furthermore, the actual distances proposed as buffer zones are often larger than would be consistent with leaving local clues.

A variety of distance-related processes have thus been outlined by those with an environmental criminology bias (notably Brantingham and Brantingham, 1981) which could be seen logically to be in conflict. One is a tendency to minimize effort close to home, which would predict that crimes are in a closely circumscribed area. A second is the tendency to keep a minimum distance away from home. These two processes combined would lead to the prediction of an optimum distance from home to all of a particular type of offense. However, the general finding is one of an aggregate decay of the frequency of crimes as their distances increase from home. These processes are derived from a consideration of instrumental crimes often with a tangible material benefit, such as theft or robbery. So although they doubtless have relevance to violent offenses there are questions about how important emotional issues are ignored by such rational models.

Two further complexities raise questions about the relevance of these rational processes to serial killers. First, there is typically more than one location involved in their activities. Besides the location of the site where the victim's body is dumped (BD) there is also usually at least one other important site, the point at which the victim is first encountered (PFE). All three of the processes indicated above, least effort, buffer zone and decay function, would predict the BD and PFE to be close together. Second, none of the three processes would lead to any predictions in the changes over time of the distance of the crimes from home.

A different emphasis from these essentially economic, rational processes would lead to predictions of differences between BD and PFE site distances from home as well as differences over time. This is an emphasis drawn from the role of the crimes in the unfolding life "narrative" of the offender (Canter, 1994). Briefly, within this framework the crimes are seen as a product of the lifestyle of the offender but also by virtue of the experience of the crimes the offender changes his view of himself and the ways he commits his crimes. This leads to the proposal that the home, being an important focus for life activities, acts as a structuring device for the development of the criminal activity. Within any particular crime there will be some activities, notably those to do with the leaving of evidence, that may be guided by buffering processes and the optimization of locations away from home to maximize value for effort, but over all it would be predicted that as the crimes proceed they will be incorporated more fully into the domestic ambit.

The theoretical analysis of people's bonds with the tangible surroundings of the home environs is found in several disciplines (Buttimer, 1980; Copper, 1974; Fried, 1963). Through daily travel the home environment becomes a unique place of familiar, known and predictable activities, people and physical

elements, a focal point of one's experiential space (Feldman, 1988). Thus, through habitual, focussed and satisfying involvement in a residential locale, the tangible home area becomes an enduring symbol of self, the continuity of one's experiences and that which is significant and valued by the inhabitant. The landscape around the home base may thus be hypothesized to provide serial killers with those enduring symbolic experiences. If their crimes, as hypothesized, do indeed develop as an elaboration of their daily activities, rather than as some distinct work-life activity, then it would be predicted that the home would be geographically as well as symbolically central to their criminal activities.

A study of serial rapists (Canter and Gregory, 1994) does show that the home can be used as a basis for defining the area in which crimes were committed; they showed that very few offenders "commuted" like workers into areas to commit their crimes but that in 86 percent of the cases the home was within a circle defined by the two crimes furthest from each other. A number of other studies have also shown that criminals are apparently reluctant to travel very far from their home base to commit their crimes (Baldwin and Bottoms, 1976; Rhodes and Conly, 1981). However, none of these studies have dealt with serial killers and considered both the BD and the PFE as well as considering the possibility in changes in distances traveled over time.

The present study, therefore, set out to explore three sets of hypotheses of serial killers' journey to crime:

H1: The home operates as a focus for the activities of serial killers in apprehending their victims and leaving their bodies. The focus is hypothesized as being the most likely center of gravity of their actions.

H2: There will be differences in the distances traveled to apprehend victims and to leave their bodies. It is proposed that the dumping of the body carries most evidential implications and therefore is likely to be at a further distance as well as being more likely to be shaped by buffering processes.

H3: The distances serial killers travel to dump the victims' bodies are likely to change systematically over time while the victims' points of fatal encounter locations are not. The counter-intuitive possibility that this change relates to an increasing incorporation of all his killing activities into his domestic area will also be tested.

Data sample

The study involved 54 male US serial murderers. All the cases were solved. Each offender was convicted of at least ten murders, committed on different dates and in different locations. Most of the killers were suspects in additional murders; however, those cases were not included in the study because the offenders were never charged with the additional crimes. Only the first ten murder victims were considered in the present study so that in total the details on 54 serial killers and 540 victims were used.

The data were collected from various police departments throughout the USA including, but not limited to, intelligence sources such as the Homicide Information Tracking System (HITS), Violent Crime Apprehension Program (VICAP), and Homicide Assessment and Lead Tracking System (HALT). Additional data on specific cases were obtained from court transcripts by accessing Lexus and Westlaw, the on-line law databases. The material used to generate the data matrix was derived from police eyewitness accounts including visual sightings and telephone conversations, police field reports, detective reports and medical examiners' reports. Independent corroboration was used when necessary. Considerable effort was taken to locate and record the physical addresses of the offenders' home bases, the victims' points of fatal encounter (PFE), and the victims' body dump sites (BD). Throughout the study home base is defined as the location where the offender was living during the time they were committing their crimes. In most instances the data included one offender and one home base. Point of fatal encounter is defined as the initial contact site or last seen location of the victim. Body dump location is defined as the final resting place where the victim's body was discovered. Additional care was used to determine and record the killings in sequence as they were committed.

In 92 percent of the cases neither the offender nor the victim knew each other prior to the encounter. In 3 percent of the cases both people were friends who had seen each other on a regular basis. In just 1 percent of the cases victims had a family relationship. In 4 percent of the cases the offender and victim barely knew each other, seeing each other perhaps once in a year; this included one-way acquaintance, where the offender knew the victim but the victim did not know the offender. At the time of the murders, 28 percent of the victims were actively working as prostitutes.

Mapping the crimes

The physical address of each serial killer's home base along with the address of each victim's abduction and body disposal site was mapped using Map Expert. This is a commercially available mapping program which features state boundaries, major lakes and oceans, and the interstate highway network. The map projection displays information about the terrain and topography of the area being viewed. In addition, the map program provides viewing down to street levels for all parts of the USA, including cities.

Direct point-to-point Euclidean (i.e. as the crow flies) distance measurements were performed on the geographical locations. The distances were recorded in miles. For each offender the distances from the offender's home to every one of his PFE and BD sites were calculated as well as the distances between every PFE and BD. The distance matrix so created was the basis for all subsequent analysis.

Results

Smallest space analysis and the home as a focus of serial murder

In order to explore the role of the home in the geographical locations of both BD and PFE sites it is necessary to consider the relationship that every location has to every other. This can be posed as the question, what is the best approximation to a two dimensional representation of the average distance between every location? If one location, say the home, was on average typically a long distance from most of the PFE sites then such a representation ought to place the home in a region that is at some distance from the PFE sites. But in order for such a geometric representation of the average spatial distances to be valid it must take into account the distance that every location has from every other location. In doing so such a representation can also represent the relative average distances between the PFE and BD sites.

In effect, a geometric representation of the distances between all the locations across the whole sample allows the testing of a multivariate model of offender geography. That model contains the following facets:

- *The nature of the location*, with the elements home, PFE and BD – with the hypothesis that there will be some order in the distances such that typically the distance from home to PFE will be less than the distance from home to BD. If the home has a significance for both the PFE and the BD then if there is the order hypothesized the home will be central.
- *The temporal sequence of the offenses*. Some difference between earlier and later offenses in the distances and directions traveled is hypothesized.

An appropriate statistical procedure for testing this model is smallest space analysis (SSA), which is a multi-dimensional scaling technique that finds the best fit within a specified dimensionality between, on the one hand, a matrix of associations, in this case the mean distances between all locations across the 54 offenders, and on the other a geometric representation of those associations as distances in a Cartesian space (i.e. the axes have no external reference).

Smallest space analysis

Smallest space analysis was developed by Guttman (1968) and computerized by Lingoes (Bloombaum, 1970). The program deals with the off-diagonal elements of a square, symmetric matrix of association coefficients (Lingoes, 1973). The advantage of SSA over other algorithms lies in its robustness and rational step-size (Lingoes, 1973). This is mainly because the algorithm only attempts to find the best fit between the ranks of the association coefficients and the ranks of the distances in the geometric space. Such a matching of ranks can be shown to give a mathematically more efficient solution as well as being less sensitive to extreme values and is the reason the procedure is called “smallest” space analysis. It also leads to the procedure being recognized as non-metric. It is also appropriate in many psychological studies, such as the present one, as psychological hypotheses are usually about the relative associations between

entities rather than their absolute differences. The hypotheses here are not precise enough to say how much bigger or smaller the relative distances are in comparison with each other, merely that there are consistent differences in rank. The resulting geometric representation is thus often more amenable to direct interpretation in relation to a set of hypotheses than would be procedures using metric algorithms or specific externally defined axes.

A triangular association matrix was generated for the SSA analysis using the mean interpoint distances that serial killers traveled between all their home bases, victims' points of fatal encounter and body dump sites. The mean interpoint distances were calculated for each killer by taking the Euclidean distance between each crime site and every other and dividing by the number of locations recorded. The result for a two-dimensional SSA is shown in Figure 1.

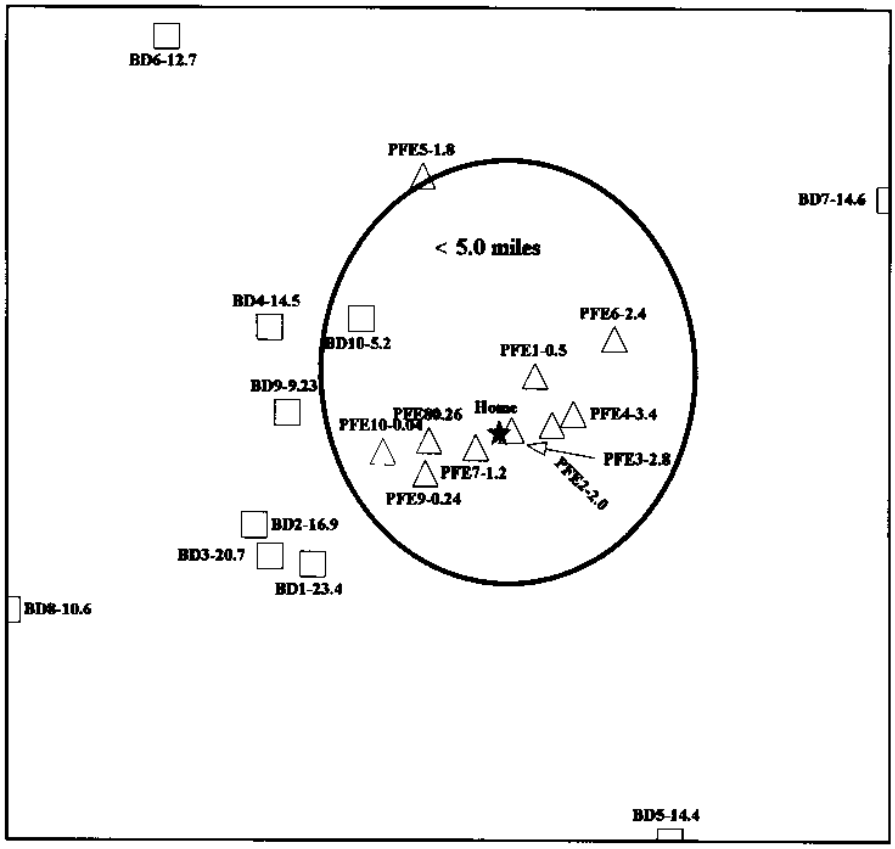

Figure 1.
US serial killers two-dimensional SSA plot: mean distances offenders traveled from their home bases to victims' points of fatal encounter and body dump locations

The home as focus

The goodness of fit between the empirical coefficients and the resulting representation is measured by a Guttman and Lingoes (GL) coefficient of alienation (Shye, 1985). The smaller the coefficient of alienation the better the fit (Brown, 1985; Shye, 1985). A generally acceptable coefficient of alienation is 0.24. The SSA plot in Figure 1 has a (GL) coefficient of alienation of 0.30, which is a little high, indicating that the original matrix of average distances may require more than two dimensions to represent all their nuances. (The distance metric used to generate the SSA in Figure 1 is based on "Manhattan" distances. This provided the interpretable plot in two dimensions. A similar result using Euclidian distances was found in three dimensions. For simplicity and clarity the city block solution is presented here.) However, as Shye and Borg (1995) have clearly argued, measures of goodness of fit can only be taken as broad indications and the actual interpretability of the solution carries considerable scientific weight.

Each point in the SSA plot represents an average location so the relative distances across the plot represent the relative distances the killers traveled on average from their home bases to abduct victims and dispose of their bodies. The serial killers' home base is represented by the star. So, for example, Figure 1 shows that the distance from home to the first point of encounter (PFE1) was considerably less than the distance between the seventh and eighth body dump site (BD7 to BD8).

The interpretation of Figure 1 is assisted by recognizing that the home is located by the computer within a region that is surrounded by the PFE sites, which are in turn surrounded by the BD sites. This thus clearly demonstrates that the home plays the role of the geographical focus for these offenses. The relative geometry is such that the best solution the SSA algorithm can find does place the home in a position such that all the distances between each of the locations, in effect, surround the home. This accords well with the studies cited earlier that argue for a central significance to the offender in the location of his home.

PFE victim and BD locations

Nine of the PFE sites are located on the SSA closer to the home than any of the BD sites. This indicates that the offenders, on average, tended to make initial contact with their victims closer to home than the locations in which they eventually place the bodies. The fifth PFE, while still within the same general region as indicated on the SSA plot, is nonetheless further from the home than a number of the BD sites. This is worthy of note but may be an artifact of this particular data set and the two dimensional solution.

The finding that the PFEs are relatively closer to the home than the BD sites is of considerable interest because it indicates that an emphasis towards life style considerations rather than rational modeling may be valid for these types of offenses. It suggests that if a buffering process is present it is more obviously apparent for the BD sites than for the initial encounter with the victim.

Temporal sequences

The SSA does indicate that the first six PFEs are closer to each other and a little separate from the remaining four. This indicates that the offender has a tendency to move to a slightly different area on the other side of the home after the first abductions. A similar but more complex process is revealed for the BD sites. The first three are located on average quite close to each other, interestingly on the opposite side of the home from the initial points of encounter. Subsequent dump sites are spread out on differing axes, such that BD5 is across the plot from BD4, BD6 is across the plot again with BD7 and BD8 at opposite ends of an axis that is orthogonal to the BD5-BD6 axis. This certainly supports the idea of offenders who are attempting to spread the locations of their dump sites and thus, presumably, reduce the risk of detection.

As mentioned, the SSA results are based on non-metric algorithms that find the best fit, in this case, a two dimensional solution. There are thus approximations in these results that, although valuable in supporting the general model, do not allow more precise testing of the various related hypotheses. A further set of parametric statistical analyses were therefore carried out.

Distances to PFE and BD sites over the ten offenses

Figure 2 shows the mean distances serial killers traveled from their home bases to victims' abduction and body dump locations. This provides another way of considering the results already found from the SSA. This graph cannot indicate the central significance of the home but because it uses conventional interval metrics, it does show clearly how much further serial killers traveled to dispose of their victims' bodies on average than to abduct them. The overall home to BD mean is 14.3 miles (SD = 5.0). The overall mean distance serial killers traveled from their home bases to abduct their victims is 1.46 miles (SD = 1.25).

The differences in the average distances for each PFE and each BD in the sequence is statistically significant for the first eight offenses as summarized in Table I. This provides further strong support for the conclusions derived from the SSA, but shows that these differences are of a considerable size. In this sample at least, it can be claimed with some confidence that the point at which the offender makes contact with the victim and abducts her is typically close to his home, but he then will travel some distance, often choosing different directions for each offense, to get rid of the body.

Changes over time

Table I does show that the differences between the travel distances for PFE and BD are not significantly different for the last two offenses in these series of ten. The basis for this can be seen in Figure 2. The PFE distances do not appear to change consistently over time whereas the BD distances decrease from first to tenth. Statistical tests show the scale of these apparent trends.

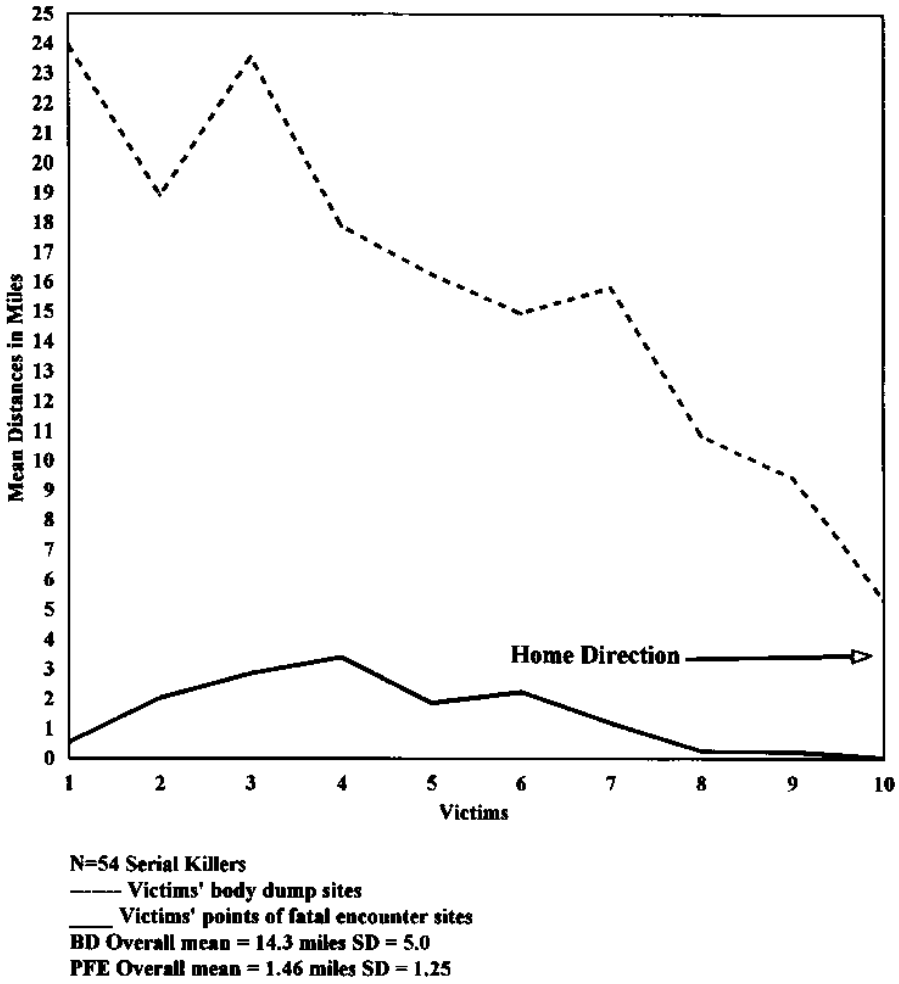

Figure 2.
US serial killers: mean distances offenders traveled from their home bases to victims' points of fatal encounter and body dump locations

Changes in distance to PFE

Table II summarizes the one-way analysis of variance that examined the distances traveled to the PFE for each of the ten offenses, across all 54 offenders. This shows that none of the distances are statistically different from each other. Further analysis was performed using one-way repeated measures ANOVA (Scheffe test) on the within group differences between the victims' points of fatal encounter sites. The difference within the groups (victims) is not significant over time $F(10,530) = 0.222$ $p > 0.05$. The mean distance serial killers traveled from their home bases to abduct the first victims in the series was 0.5 miles. The mean distance serial killers traveled from their home bases to abduct their tenth victims was 0.2 miles. Thus a remarkably consistent closeness to home in the distances the offenders traveled to make contact with their victims is revealed.

Offense	Home to PFE $\bar{x}$ (SD)	Home to BD $\bar{x}$ (SD)	*t*-value
1	0.55 (1.9)	23.4 (64.7)	2.24**
2	2.03 (3.9)	16.9 (25.9)	3.04*
3	2.86 (3.8)	20.7 (40.8)	2.64**
4	3.40 (4.0)	14.5 (19.1)	3.61*
5	1.87 (3.6)	14.4 (21.4)	3.91*
6	2.24 (2.1)	12.7 (26.9)	3.02*
7	1.20 (3.0)	14.6 (21.2)	2.09**
8	0.26 (2.2)	10.6 (21.0)	4.36*
9	0.24 (1.6)	9.23 (8.0)	1.27
10	0.04 (1.7)	5.28 (7.7)	0.33

Notes: *t*-test at 95 per cent CI
DF = 53
*Significance at $p < 0.01$
**Significance at $p < 0.05$
Each offense equals 54 crime sites

Table I.
T-tests: mean distances serial killers traveled from their home bases to victims' point of fatal encounter and body dump locations

Changes in distance to the body dump locations

The mean for all the first body dump locations was 24.5 miles and the mean for all the tenth body dump ten locations was 0.4 miles from the offender's home. The one-way ANOVA results are given in Table III. Tukey's HSD *post hoc* test was run on the body dump distances. Tukey's HSD test is a more conservative test of significance. It would be expected that if a significance is found using the Tukey's HSD for the BD sites, then the actual significance could be expected to be greater. The linear polynomial function was chosen. The polynomial linear function allows the data to be partitioned using sum of squares polynomial trend components. Each victim, then, was a treatment. The ANOVA results on the BD means are given in Table III. To test the within group differences between the victims' body dump sites, a one-way repeated measures ANOVA

Source	Sum of squares	DF	Mean square	*F*-ratio	*F*-probability
Mean (between)	127.47	9	14.16	1.775	0.07
Linear (term)	8.29	1	8.29	1.039	0.31
Deviation from	119.17	8	14.89	1.867	0.06
Linear error (within)	672,533.1	530	1,268.93		
Total	676,961.0	539			

Notes: Tukey's HSD not significant at $p < 0.05$
Levene's (homogeneity of variance) $F(10,530) = p < 0.01$ two-tailed
$N = 540$ PFE distances

Table II.
One-way analysis of variance from mean distances serial killers traveled from their home bases to victims' points of fatal encounter sites

(Scheffe test) was run on the BD mean distances. The differences within the groups (victims) over time is significant $F(10,540) = 54.60$ $p < 0.001$.

The relationship between distances serial killers traveled from their home bases to dispose of victims changes over time ($F = 4.09$, $p < 0.0001$). As the number of victims increased the distances from home decreased in a broadly linear way as illustrated in Figure 1.

Source	Sum of squares	DF	Mean square	*F*-ratio	*F*-probability
Mean (between)	28,190.5	9	3,132.2	4.09	0.0000*
Linear (term)	6.6	1	6.6	0.08	0.9258
Deviation from	28,183.8	8	3,522.9	4.61	0.0000*
Linear error (within)	404,965.54	530	764.08		
Total	433,156.06	539			

Notes: *Tukey's HSD significant at $p < 0.001$
Levene's (homogeneity of variance) $F(10,530) = p < 0.01$ two-tailed
$N = 540$ BD distances

Table III.
One-way analysis of variance of distances serial killers traveled from their home bases to victims' body dump sites

Conclusions

Home, abduction and dumping

The results of the present study indicate that as the number of murders increases, killers generally cover a narrower area in which to leave the bodies of their victims, until the ninth and tenth offenses where the offender may be disposing of bodies quite close to his home. This pattern contrasts markedly with the locations at which the initial contact is made with the victim. All ten of the murders in the sequences studied here tended to be close to the home base of the offender, typically less than a couple of miles from his residence.

Such findings are in accord with a perspective that sees serial killings growing out of the daily activities and contact patterns of the offender. Rather than seeing the offender as balancing some economic effort against perceived gain, as may be relevant to crimes that are directly financially motivated, these results indicate the offenses evolving out of day-to-day dealings with others. A recognition of potential victims in the area around his home to which the offender normally has access is hypothesized as the first stage in this process. Once a victim has been abducted and killed then an attempt is made to distance the body from known haunts of the offender. Subsequent victims are found in similar ways – see the marauding model proposed for serial rapists (Canter and Larkin, 1993). The removal and placing of the bodies, however, involves a more conscious process in which the evidential implications are likely to be considered by the killer. The sites at which the bodies are left are thus more likely to be dispersed away from the home. The finding, possibly counter-intuitive, for the present set of serial killers, that the sites at which they dump

the bodies get closer to their home as the series progresses is most intriguing. It accords with the proposal that their offenses become increasingly integrated with their daily lives, and that some sort of growing confidence, or growing determination to reduce the risk of transporting the bodies, leads to the dump sites and the encounter sites being closer together. Clearly, future research is required to explore more closely this important process.

Psycho-geographical profiling in relation to ongoing police investigations

With every act that leaves behind evidence associated with each crime in the series, the killer provides information that can indicate with increasing accuracy the location of his home base. The results reported indicate, however, that the location of initial contact with the victims may be of more direct assistance in helping to delimit the area in which the offender resides than the sites at which victims' bodies are discovered. Clearly, though, the BDs are more likely to be established objectively by the police than the PFEs. In this case the indications are that the later BDs may be of more assistance, being closer to the home than the earlier BDs. Such a finding has direct implications for systems such as criminal geographical targeting (Rossmo, 1995), leading to the hypothesis that his procedure might be more efficient if it commenced with the most recent offenses, adding earlier BD offenses subsequently.

The results also indicate, as shown clearly in the SSA, that when considering any number of body dump locations that have been determined to be linked, the police should view these sites with caution for predicting the home area of a serial killer. The systematic changing of locations and distances relative to the home base may be a deliberate ploy to distract police attention from the killer's home base.

This raises another interesting point. What if police do not know exactly what number of victims were murdered in the series or their sequence? In a serial murder case where any number of victims may have previously been linked through other forms of forensic analysis (e.g. DNA or fingerprints), then the body dump sites found furthest apart may be hypothesized to be the first victims in the series. Those clustered together, near any number of abduction sites, are more likely recent murders. The latter areas should be the sites at which investigators focus their proactive policing efforts.

These results certainly support the view that investigative efforts should go into interviewing people within the neighborhood from which victims go missing in order to pinpoint precisely the address or location where the victim may have been last seen. The victim's last seen site can be developed from any number of sources: eyewitness accounts; visual sightings; telephone conversations; official documents, such as traffic citations, police field reports, jail booking logs, long distance calls, toll records, and credit card receipts. As Ford (1991) has elaborated, it is imperative for investigating officers to follow up on where the predator met his prey.

References and further reading

Amir, M. (1971), *Patterns in Forcible Rape*, University of Chicago Press, Chicago, IL.

Baldwin, J. and Bottoms, A.E. (1976), *The Urban Criminal: A Study in Sheffield*, Tavistock Publications, London.

Bloombaum, M. (1970), "Doing smallest space analysis", *Journal of Conflict Resolution*, Vol. 14 No. 3, pp. 409-15.

Brantingham, P.J. and Brantingham, P.L. (1981), *Environmental Criminology*, Waveland Press, Prospect Heights, IL.

Brantingham, P.J. and Brantingham, P.L. (1984), *Patterns in Crime*, Macmillan, New York, NY.

Brown, J. (1985), "An introduction to the uses of facet theory", in Canter, D. (Ed.), *Facet Theory: Approaches to Social Research*, Springer-Verlag, New York, NY.

Buttimer, A. (1980), "Home, reach, and the sense of place", in Buttimer, A. and Seamon, D. (Eds), *The Human Experience of Space and Place*, St. Martin's Press, New York, NY.

Canter, D. (1994), *Criminal Shadows*, Harper Collins, London.

Canter, D. and Gregory, A. (1994), "Identifying the residential location of rapists", *Journal of the Forensic Science Society*, Vol. 34, pp. 169-75.

Canter, D. and Larkin, P. (1993), "The environmental range of serial rapists", *Journal of Environmental Psychology*, Vol. 13, pp. 63-9.

Canter, D., Missen, C. and Hodge, S. (1996), "A case for special agents?", *Policing Today*, Vol. 2, pp. 23-7.

Capone, D.L. and Nicholas, W. Jr (1975), "Crime and distance: an analysis of offender behavior in space", *Proceedings of the Association of American Geographers*, Vol. 7, pp. 45-9.

Capone, D.L. and Nicholas, W. Jr (1976), "Urban structure and criminal mobility", *American Behavior Scientist*, Vol. 20, pp. 199-213.

Copper, C.C. (1974), *The House as Symbol of Self*, Institute of Urban and Regional Development, University of California, Berkeley, Reprint No. 122.

Davies, A. and Dale, A. (1995), "Locating the stranger rapist", *London Home Office Police Department*, Special Interest Series Paper 3.

Douglas, J. and Olshaker, M. (1996), *Mindhunter*, Heinemann, London.

Feldman, R.M. (1988), "Psychological bonds with types of settlements: looking back to the future", International Association of Psychology and Society, *10 Proceedings*, Vol. 2, Delft University Press, Delft, pp. 335-42.

Ford, D. (1991), "Investigating serial murder: the case of Indiana's gay murders", in Egger, S. (Ed.), *Serial Murder: An Elusive Phenomenon*, Praeger, New York, NY.

Fried, M. (1963), "Grieving for a home", in Duhl, L. (Ed.), *The Urban Condition*, Basic Books, New York, NY.

Guttman, L.A. (1968), "A general nonmetric technique for finding the smallest coordinate space for a configuration of points", *Psychometrika*, Vol. 33, pp. 495-506.

Hickey, E. (1991), *Serial Murderers and Their Victims*, Brooks/Cole, Pacific Grove, CA.

Holmes, R. and DeBurger, J. (1988), *Serial Murder*, Sage, Newbury Park, CA.

Holmes, R. and Holmes, S. (1996), *Profiling Violent Crimes: An Investigative Tool*, 2nd ed., Sage, Newbury Park, CA.

Jenkins, P. (1993), "Chance or choice? The selection of serial murder victims", in Wilson, A.V. (Ed.), *Homicide: The Victim/Offender Connection*, Anderson Publishing Company, Cincinnati, OH.

Keppel, R. and Weis, J. (1994), "Time and distance as solvability factors in murder cases", *Journal of Forensic Science*, JFSCA, Vol. 39 No. 2, pp. 386-401.

Lingoes, J.C. (1973), "The multivariate analysis of qualitative data", *Multivariate Behavioral Research*, Vol. 3, pp. 61-94.

Newsweek, (1994), "Murder: a week in the death of America", August, pp. 23-49.

Pettiway, L.E. (1982), "Mobility of robbery and burglary offenders: ghetto and non-ghetto spaces", *Journal of Urban Affairs Quarterly,* Vol. 18 No. 2, pp. 255-69.

Pyle, G.F. (1974), *The Spatial Dynamics of Crime*, University of Chicago, Department of Geography, Chicago, IL.

Ressler, R.K. and Shachtman, T. (1992), *Whoever Fights Monsters*, Simon & Schuster, London.

Rhodes, W.M. and Conly, C. (1981), "Crime and mobility: an empirical study", in Brantingham, P.J. and Brantingham, P.L. (Eds), *Environmental Criminology*, Sage, Beverly Hills, CA.

Rogers, R., Delores, C. and Anderson, D. (1991), "Serial murder investigations and geographic information systems", presentation, Annual Meeting, Academy of Criminal Justice Sciences, Nashville, TN.

Rossmo, D.K. (1993), "Multivariate spatial profiles as a tool in crime investigation", presentation, August, Workshop on Crime Analysis through Computer Mapping, Chicago, IL.

Rossmo, D.K. (1995), "Place, space, and police investigations: hunting serial violent criminals", in Eck, J.E. and Weisburd, D. (Eds), *Crime and Place*, Criminal Justice Press, Monsey, NY.

Rossmo, D.K. (1996), "Geography, profiling, and predatory criminals", in Holmes R. and Holmes, S., *Profiling Violent Crimes: An Investigative Tool*, 2nd ed., Sage, Newbury Park, CA.

Shye, S. (1985), "Nonmetric multivariate models for behavior action systems", in Canter, D. (Ed.), *Facet Theory: Approaches to Social Research*, Springer-Verlag, New York, NY.

Shye, S. and Borg, I. (Eds) (1995), *Facet Theory: Form and Content*, Sage, Newbury, CA.

Skogan, W.G. and Antunes, G.F. (1979), "Information, apprehension, and deterrence: exploring the limits of police productivity", *Journal of Criminal Justice*, Vol. 7, pp. 219-34.

Stote, R. and Standing, L. (1995), "Serial and multiple homicide: is there an epidemic?", *Social Behavior and Personality*, Vol. 23 No. 4, pp. 313-18.

US Department of Justice (1991), *Serial/Mass Murder*, (National Institute of Justice topical search TS 011664) Government Printing Office, Washington, DC.

Zipf, G. (1950), *The Principle of Least Effort*, Addison-Wesley, Reading, MA.