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Prioritizing Burglars: Comparing the Effectiveness of Geographical Profiling Methods

David Canter & Laura Hammond

The effectiveness, in prioritizing suspects, of six geographical profiling methods are compared by determining the rank to which each of 92 prolific burglars was assigned, from the total of 400 known burglars, who were selected from a large metropolitan database because they resided in the borough in which the crimes occurred. Using mean and median ranked prioritization of actual offenders, as well as the percentages that appeared in the top 5% of rankings and the area under the curve of a specially developed 'Ranked Prioritization Function,' $RP_{(f)}$*, it was found that Dragnet using a logarithmic decay function and the distance from the centre of gravity produced the lowest average ranks, with 72% of the actual offenders in the top 5% of prioritized rankings. The implications of the findings are discussed.*

Keywords: Prioritizing Offenders; Geographical Profiling; Volume Crime; Distance Decay; Dragnet; Burglary

Introduction

A variety of geographical profiling procedures based on models of criminal spatial behaviour are becoming increasingly commonplace within the investigative domain.

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They apply geometric functions to crime scene locations in order to prioritize the locations at which an offender may have a base. The growing number of possible procedures for carrying out such analyses raises questions about the operational effectiveness of the different methods and their implications for understanding criminality.

Most evaluations of different methods have examined the average distance that offenders' bases are from a point that a particular procedure indicates (Canter, Coffey, Huntley, & Missen, 2000; Rossmo, 2000; Snook, Canter, & Bennell, 2002; Snook, Taylor, & Bennell, 2004). However, average distance is only an approximation of the operational utility of any system. The number of possible offenders in an area, or the scale of search that needs to be conducted, as well as other practical implications of any given location, may greatly reduce the effectiveness of even procedures that produce low average distances of offenders' bases from designated locations. As Snook, Wright, House, and Alison (2006) have illustrated, assessing the effectiveness of geographical profiling systems in prioritizing potential suspects offers a means for evaluating any procedure that is much closer to practical applications.

The effectiveness of any geographical profiling system is best carried out on real police data. But this can be problematic because of difficulties of access and weaknesses inherent in data that are not collected for research purposes (Canter & Alison, 2003). It is therefore perhaps not surprising that the majority of studies have worked with very limited data-sets and have focused on serious crimes, information on which often finds its way into the public domain. Canter et al. (2000) had a reasonably large sample of 79 series but they were the unusual crime of serial murder. Rossmo (2000) and Snook et al. (2002, 2004) employed samples of 16 offence series or less. More recently, Levine (2002), Paulsen (2005, 2006), and Snook, Zito, Bennell, and Taylor (2005) have looked at volume crimes, such as burglary and robbery, but their sample sizes have also tended to be restricted, with the exception of Paulsen's study in which 247 series were used.

There is therefore a need to compare the effectiveness of different approaches to geographical profiling on larger samples of volume crimes. Results of studies of serial killers (Canter et al., 2000; Rossmo, 2000) and serial rapists (Canter & Gregory, 1994; Canter & Larkin, 1993) indicate that the potential for geographical profiling may not be applicable to property crime. White, as long ago as 1932, Pyle, in 1974, and, more recently, Meaney (2004) have all shown that the travel distances of violent offenders are typically shorter than those of property offenders. It is therefore important to explore further one of the most common property crimes, burglary, in order to determine the likely utility of geographical profiling to police investigations.

Utility, though, will be more readily revealed using evaluation procedures that go beyond calculations of the average distance from a particular location. Determining how successful each procedure is in prioritizing potential suspects is closer to the task that detectives face. Such a study would also have more implications for operational use if it worked as closely as possible with actual police data filtering potential suspects in accordance with strategies actually available to the police force concerned. Snook et al. (2006) showed the value of such an approach for prioritizing robbers, but they were working in the small and very distinctly urbanized centre of Newfoundland. It remains an important open question as to whether geographical profiling procedures could be applied to volume crime in an area of a major metropolitan city as explored in the present study.

Measures of Effectiveness

As mentioned, the majority of studies into the effectiveness of any specific geographical profiling procedure, for example, those by Levine (2002) and Snook et al. (2002, 2004, 2005), have used error distance measures as a means of evaluation. The error distance is the distance between the point predicted by a method as having the highest likelihood of containing an offender's home or base and the actual location of their residence. In contrast, Rossmo (2000) uses 'hit scores' to measure the area searched before the offender is located, and Canter et al. (2000) and Canter and Hammond (2006), use Canter et al.'s (2000) 'Search Cost Function.' This is not a single value but a representation of the relationship between the proportion of an area searched and the proportion of a sample of offenders located within any given area. By considering the function that relates these proportions it is possible to determine the variations in effectiveness of any procedure. The key idea is that if a procedure only begins to identify a large proportion of the sample when a large area has been searched, then it is less effective than if there is a rapid increase in effectiveness in the initial increments of the search area. In other words, a function with a rapid increase in effectiveness that then levels off is of much more value than one that only increases effectiveness slowly.

As Paulsen (2006) observes, the different measures used by different researchers means that 'it is functionally impossible to determine how accurate the different profiling methods are in relation to each other' (p. 79). Therefore, the same methods need to be applied in comparisons of different procedures. Crucial to this, though, is how clearly the evaluation procedure relates to actual operational police tasks. The ranked order of the actual offender on a priority list is one such method of assessment. The search cost function has therefore been developed to a Ranked Prioritization Function, $RP_{(f)}$. The $RP_{(f)}$ reflects the relationship between where genuine perpetrators feature in ranked prioritization of all potential suspects for the offences they committed and the proportion of the sample or population achieving those ranks. The $RP_{(f)}$ can be established for any given geographical profiling technique, providing a direct indication of how effective that method would be in an actual investigation and thus giving an indication of the operational value of such approaches. The fact that it is a function, rather than a single point, also indicates the resources that would be needed for different levels of application of the approach. If a single measure is required for overall evaluation of an approach then, as will be illustrated, the area under the curve that describes the function is a good indicator of its effectiveness across a range of criteria.

Prioritization Methods

Hammond and Canter (2006) detail a number of geometrical and statistical procedures that can be applied to crime series as a means of predicting where the perpetrator of those offences might be most likely to reside. These approaches comprise a range of geographical profiling methods, ranging from procedures that only require one crime location through to the more complex algorithms that are built into geographical profiling systems. Each procedure can be used to prioritize offenders on the basis of the distance of their residential location from the point indicated by that method as having the highest probability of containing the perpetrator's home or base. For the present study six different procedures have been compared.

Distance from first offence

One of the simplest heuristics for predicting the location of an offender's residence is the distance from the location of the first known (recorded) offence that a serial offender commits. Canter (2003) illustrates how early offences in an offender's career can provide a reasonably accurate indication of the likely location of their residential base. Such crimes are likely to involve less planning, and thus to occur in areas familiar to the perpetrator, and so, in turn, are more likely to be located shorter distances from the offender's home.

Examining this proposal, Canter and Gregory (1994) found that in a large proportion of serial rapes, the perpetrator lived in the region around the location of their first offence, thus illustrating the first crime site to be a useful predictor of offender home location. Further, in a development of Canter and Larkin's 'Circle Hypothesis,' Canter and Gregory (1994) showed that circular regions around the first offence in a series of crimes could be used to indicate the general area in which an offender was living.

This simple heuristic is interesting also because it belies the idea that geographical profiling can only be applied to a series of crimes and that series needs to be five or more, as Rossmo (2000) claims. If a single, initial crime can be used to help locate an offender then geographical profiling could be of value for the investigation of one-off offences.

Distance from last offence

As an offender progresses through the offences in their criminal career then they are likely to increase in confidence, begin to take more risks. It is therefore feasible that the later offences in their criminal histories may be committed closer to home, which, as Phillips (1980) argues, involves less time, money, and effort than travelling further. As such, the last (or later) offences that a criminal commits might provide useful basis for predicting the home location of an offender.

However, there is also the possibility that the more crimes an offender commits, the more risks would be involved in offending closer to home, and so in order to evade detection they would have to travel further afield, where the risks of being identified or apprehended may be somewhat decreased (Brantingham & Brantingham, 1981). Indeed, Lundrigan and Canter (2001) propose that prolific offenders may reach the stage where they have exhausted the possibilities for crime close to their home, thereby being forced to travel further to conduct their criminal activities. If this were the case, then the later offences in a series might be expected to occur at greater distances from the offender's home or base than those offences committed previously in their criminal histories, and so the locations of later offences might be limited in terms of their ability to indicate the likely location of an offender's home.

It is certainly possible that for some offenders their first recorded crime is a better indication of home location and for others it will be their last recorded crime. It is therefore of value to include both of these possibilities in the current study. The added complication that it can never be ascertained with complete certainty from police records which is the first crime and which the last means that it is informative to take two single crimes, one of which is likely to be earlier in the series and the other later, as a comparison.

Distance from the centre of the offence circle

Any one crime in a series may be problematic as a basis for determining an offender's location, because of recording errors or the vagaries of the particular circumstances of that crime. The overall area in which offences are carried out may be a more effective basis. To define the offence domain as simply as possible Canter and Larkin (1993) proposed the 'Circle Hypothesis.' This is the hypothesis that the offender will be based within a circle whose diameter is the line joining the two crimes furthest from each other. Since Canter and Larkin (1993) first demonstrated that the majority of the serial rapists they studied were indeed based within their hypothesized circle a number of other researchers have shown that a very high proportion of offenders committing other crimes in different parts of the world were based within the hypothesized circle (e.g., Kocsis & Irwin, 1997; Meaney, 2004; Sarangi & Youngs, 2006).

The circle hypothesis does not propose a point from which to prioritize offenders. Its objective is explicitly to indicate a search area. But to include it in the present study the centre of the circle, the mid-point of the diameter, was taken as the point from which to prioritize the home locations of offenders.

Distance from centre of gravity

The two furthest crimes are clearly a sub-sample of all offences and any measure derived from them is potentially biased by their limited representation of the series as a whole. In order to consider the focal point of a crime series some summary of their whole distribution may be appropriate. Kind (1987) took this view when he proposed that the 'centre of gravity,' or 'centroid,' of a series of crimes could be used to identify the likely location of an offender's home or base. He applied this approach with some success to indicate the likely location of the home of the Yorkshire Ripper (Kind, 1987). But as discussed by Canter (2003) the arrest of the perpetrator a day or so after Kind's prediction was made and before his report reached investigating officers meant that his discovery lay dormant for some years.

Additional support for the power of the centroid as a basis for geographical profiling is provided by Canter and Gregory (1994), who reported that in the majority of the serial rape cases they studied, offenders live reasonably close to the centre of gravity of their offence locations. The centre of minimum distance has also been shown in previous comparisons of geographical profiling methods (e.g., Levine, 2002; Snook et al., 2005) to produce a low average error in predicting residential location.

The centroid of a series of crimes is the point which is the mean of the x and y coordinates, the 'centre of gravity,' being simultaneously the minimum possible distance from all of the crime locations. This point is allocated the highest probability of containing the offender's residence.

Distance from point assigned highest probability by Dragnet

The centroid method gives equal weight to all distances from any point. However, it has been demonstrated by many researchers (as reviewed by Canter & Youngs, 2007) that the further away from home the offender is the less likely an offence will occur. This 'decay' function is generally not found to be linear, tailing off more rapidly for close crimes than for further crimes. Computer-based geographical profiling systems (Rossmo, 2000) therefore adjust the calculations of the probability of the home location by applying algorithms that take into account the differential influence of distance as enshrined in a decay function of probabilities.

The Dragnet geographical profiling system (Canter et al., 2000) was developed as a research tool (Canter, 2003) and therefore has total flexibility in the form of the decay function that is drawn on for any particular set of priority calculations. It has therefore been possible to explore the impact of various forms of decay function, showing that some functions are more effective than others in reducing the search area that needs to be explored to find the offender's home location (Canter et al., 2000).

More recently, Canter and Hammond (2006) have shown that different mathematical functions may be appropriate for characterizing the decay functions of different types of crime. In particular they drew attention to two different forms of function that could productively be incorporated into Dragnet. These were an exponential function (y=a$e^{-\beta x}$) and a logarithmic function (y=a+β ln x), both with a-values of 0.5 and β-values of 1. Each of these two functions was considered as a prioritization method in its own right ('Dragnet Using Logarithmic Function' and 'Dragnet Using Exponential Function').

Geographical profiling systems such as Dragnet indicate a distribution of probabilities across regions rather than a specific point. However, Dragnet has the facility to indicate for each point in the search space the probability of that point containing the home or base of the offender because each point within the probability surface has an associated 'p-value.' This therefore allows the home locations of suspects to be put in order of priority on the basis of the p-value of that location. These values will of course vary depending on whether a logarithmic or negative exponential function was the basis of the Dragnet calculations.

Data

As the target set of crimes, data was compiled on 92 burglary series committed between 1998 and 2001 within one borough unit of a large British metropolitan police force.

The total number of offences included in the data-set was 1,600, giving a mean of 17.39 (SD = 19.09) offences per series. The minimum number of offences per series was 5 and the maximum was 137. Offences were geo-coded and mapped within ArcGIS; however, any cases where geographical information was missing or incomplete had to be removed from the sample, and only those offences for which geographical coordinates could be determined could be included.

For each offence series the point predicted as being most likely to contain the perpetrator's home or base was determined using each of the methods.

To provide a possible suspect list, an initial filtering system was used to identify the most likely suspects from the vast numbers available in the large UK metropolitan city. The original police database used contained all individuals who had ever committed an offence within the city and its surrounding area; a densely populated region where between a third and a fifth of all crimes in Britain are committed. Consequently the number of individuals who could be considered potential suspects for any given offence series was enormous.

The stages of this filtering process are illustrated in Figure 1, showing how the information contained in this vast police database was reduced to be manageable for the set of offences of interest. This is similar to the methodology for prioritizing suspects detailed by Snook et al. (2006), for their sample of armed robbers from St John's in

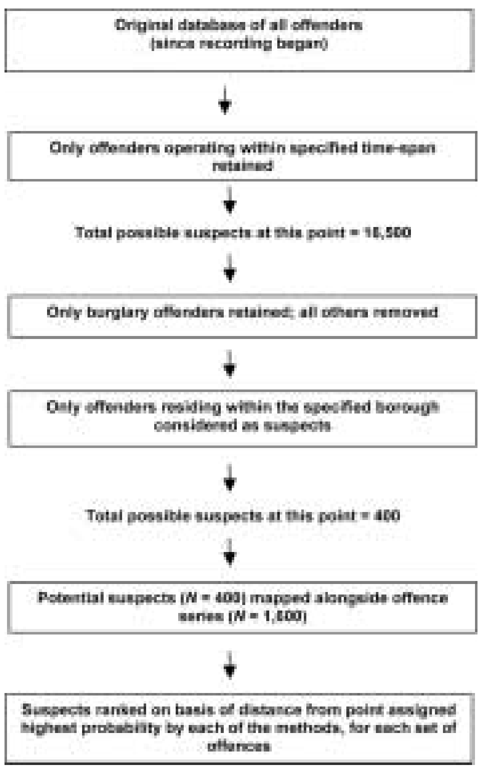

Figure 1 Filtering System to Produce List of Suspects.

Newfoundland, Canada. However, the immense volume of potential suspects in the present sample represented other, greater challenges; therefore, a more appropriate, exhaustive prioritization method, specific to this data-set, was required.

Firstly all offenders who lived outside of the area and who had not committed offences within the specified timeframe of the offence sample utilized (1998–2001) were removed. This reduced the number of suspects to 16,500. From these, only burglary offenders who resided in the borough in which the crimes occurred were retained, leaving a total of 400 potential suspects.

Limiting the offenders to the borough in which the target crimes occurred was a practical option, because of the way the police databases are organized on a borough-by-borough basis. In fact, other explorations with crimes in this area have shown, as might be expected, that offenders do not keep their actions within administrative boundaries such as boroughs. However, the police usually manage investigations of burglary within each borough. It was therefore important to establish if any geographical profiling approaches would still be effective in accord with the current police management practices.

For each crime series, the 400 filtered suspects were assigned a rank on the basis of their distance from the points assigned the highest probability by each of the methods: where actual offenders featured within the top 5% (i.e., the first 20) of prioritizations, for that series the method was assigned a score reflecting the position at which they ranked. In instances where the offender was not placed within the first 20 of the prioritized sample, then for that particular series the method was recorded as producing a 'non-rank.' The values for each of the methods across the 92 offence series were subsequently compared.

Results

Regardless of the prioritization method employed, in the majority of cases the actual perpetrator featured in the top 5% of ranked suspects. Table 1 shows the percentage of instances in which the actual culprit featured in the ranked prioritization when each of the methods was used.

Table 1 Percentages of Cases where Actual Perpetrator Featured in Top 5% of Prioritized Rankings of All Offenders Generated by Each Method.

Model used to prioritize offenders	% of cases where offender featured in top 5% of prioritized rankings
Logarithmic function	72
Centre of gravity	72
Exponential function	66
Last known offence	64
First known offence	59
Centre of circle	46

Table 2 Friedman Test Statistics.

N	92
Chi-square	46.207
df	5
Asymp. sig.	0.000
N	92
Chi-square	36.607
df	5
Asymp. sig.	0.000

Both the centre of gravity and using a logarithmic function within the Dragnet system ranked actual offenders in the largest proportion of cases (72%). The percentages were less for each of the other methods, with distance from the centre of the circle resulting in the fewest offenders featuring in prioritized rankings (46%).

Friedman tests (Table 2) found significant differences between the methods, both in terms of the proportions of instances in which they featured actual offenders in ordered rankings ($p < 0.001$) and the positions in which perpetrators placed ($p < 0.001$).

The average ranks (Table 3) achieved by the logarithmic function in Dragnet and centre of gravity again show them to be the most effective of the methods considered, achieving the lowest mean and median values. The other methods followed in the same order as before, with the centre of the circle producing the lowest mean (15.15) and median, illustrating that the majority of offenders failed to feature in the top 5% of prioritizations.

It should be noted that the mean values suggest a slight operational advantage for the use of a logarithmic function within the Dragnet system over the centre of gravity of a crime series; despite both placing actual perpetrators in prioritized rankings in the same percentage of instances and both producing a median rank of 5, the logarithmic function in Dragnet and the centre of gravity methods generated means ranks of 8.95 and 9.21, respectively.

Exploring the mean and median ranks of offenders provides only a crude indication of how effective a particular approach is. Earlier works, such as the evaluation of

Table 3 Mean and Median Ranks at which Actual Offenders Placed in Prioritized Rankings of All Offenders for Each of the Methods.

Method	Mean rank (SD)	Median rank
Logarithmic function	8.95 (8.349)	5
Centre of gravity	9.21 (8.256)	5
Exponential function	10.55 (8.461)	7
Last known offence	11.11 (8.416)	9
First known offence	11.96 (8.424)	10.5
Centre of circle	15.15 (7.536)	Non-rank

geographical profiling by Canter et al. (2000), have demonstrated the value of cumulative graphs illustrating the functional relationships between observed results and the proportion of the sample or population achieving these values.

As suggested previously, using the 'Ranked Prioritization' functions ($RP_{(f)}$s) for the methods enable the operational value of each to be assessed, by relating the ranks achieved to proportions of the sample. The $RP_{(f)}$ for each of the methods is given in Figure 2.

Whilst the $RP_{(f)}$s show the logarithmic function in Dragnet and the centre of gravity methods to place offenders in the same proportion of instances overall, the forms of the functions again illustrate a marginal advantage for the former: up until the elbow in the $RP_{(f)}$ for the logarithmic function in Dragnet, at around rank 7, the function primarily lies above that of the centre of gravity. This highlights the fact that the proportions placed in higher ranks were greatest for the logarithmic function in Dragnet; in over 50% of instances it placed the actual perpetrators in the top 1% of prioritized rankings and in almost 60% of cases in the top 2%. In contrast, for the centre of gravity these figures were lower; around 50% of offenders featured in the top 1% of ordered rankings, and slightly less than 55% in the top 2%.

Further evidence for the slight superiority of Dragnet using a logarithmic function as a means of prioritizing offenders is provided by comparison of the sizes of the area under the $RP_{(f)}$ curves for each of the methods (Table 4). These values enable the overall effectiveness of the methods in prioritizing the search for an offender to be assessed on the basis of the form of the functions that they produced, and the approaches to be

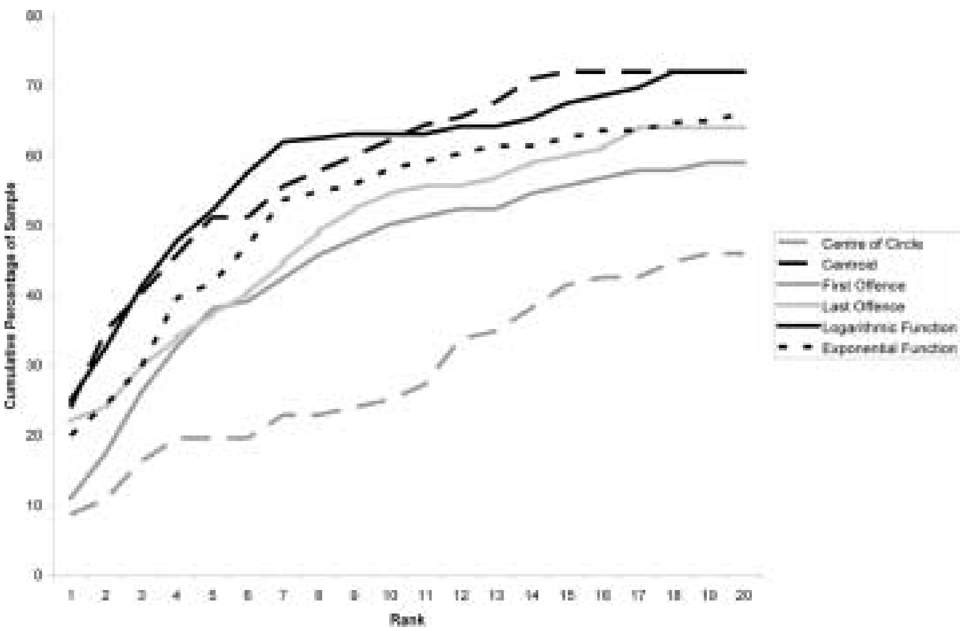

Figure 2 Ranked Prioritization Functions for Each of the Methods.

Table 4 Size of Area under Ranked Prioritization Function Curves for Each of the Methods

Method	Area under $RP_{(f)}$
Logarithmic function	1,137.30
Centre of gravity	1,135.80
Exponential function	1,010.00
Last known offence	949.40
First known offence	873.20
Centre of circle	559.95

rated accordingly. Although marginal, the logarithmic function in Dragnet does have the largest area under the curve.

Discussion

The present study worked with a sample of all offenders known to be active in a borough of a major British city over a four-year period. The crimes that were used were also all series of more than five burglaries that occurred in the borough over the same time period. The sample can, therefore, claim to be the population of offences and offenders that were relevant for the study rather than some representative sub-section of that population. Therefore, the fact that even the weakest geographical profiling method explored, the distance from the centre of a circle defined by the two furthest crimes, still located almost half of the actual offenders in the top 5% of the prioritized rankings bodes extremely well for the operational utility of geographical profiling procedures with burglars.

The finding that both the first known offence and the last known offence led to well over half of the offenders being located in the top 5% also lends support to the argument developed with detailed case examples by Canter (2003), that geographical profiling can be applicable when only one crime is being investigated. There is no requirement for a set number of crimes to be present in a series before the procedures can be applied. In addition, the similarity in results for the first and last crime in a series does suggest that notions of geographical development of offence area over time have to be treated with caution. It is possible the increases in any journey-to-crime length are more likely to be a consequence of the details of the crime, such as whether the offender may be recognized in that area, or there is an increased police presence in the area.

The results also illustrate the value of the Ranked Prioritization Function as a way of assessing the likely practical utility of any approach. Indeed, the finding that some procedures generate the actual offender provides in the top 5% of offenders in over 70% of the series, with a median rank of 5, helps to show sceptical police officers that if they were to use this approach, the indications are that they would identify the culprit after having knocked on fewer than five doors.

The ranked prioritization function also helps to move the debate beyond the consideration of average distances from a fixed point. These functions illustrate the working power of any given approach. They could be used, for example, to determine when a search was likely to be less productive. For example, in most cases if the top seven offenders on the prioritization list are not the culprits then the investigative team will know they are probably in for a very long search.

The power of the two most effective approaches in dealing with burglars is also worthy of note. The early writing on geographical profiling, as in other areas of offender profiling, gave the impression that the approach was only relevant to unusual, very serious crimes. This study lays that view to rest for good, showing that volume crime is just as amenable to geographical profiling as serial rape or serial murder, possibly more so. Given that such offences account for a large proportion of police time and investigative resources, this is a finding of considerable practical significance.

Using a logarithmic function in Dragnet and the centre of gravity of an offence series proved the most effective means of prioritizing offenders overall. This is a finding worthy of further consideration, as it appears the methods that were more complex in nature, and which accounted for all of the offences in a series, were the most effective means of prioritizing the search for an offender.

There has been some debate about the need for geographical profiling software as decision support aids for investigators, articulated most clearly by Snook et al. (2002). The present results that show the value of working from the centroid, which can be estimated by eye with reasonable accuracy, may be seen as lending some support to this argument. But, as Canter (2005) has pointed out, there are many other factors to consider in the application of geographical profiling procedures than the figure that emerges from a research study. The consistency and reliability with which geographical estimates can be determined will, for instance, be much greater for a computer than a person. But the present study has also shown that the production of a prioritized list of suspects can be very productive. This would be exceptionally time-consuming without the assistance of computers. So, although Snook et al. (2006) do not directly acknowledge this, their use of computers in that study somewhat negates the arguments that the same authors put forward challenging the use of computers in their earlier paper (Snook et al., 2004).

The only method that proved less efficient at prioritizing the search for an offender was using the distance from the centre of the offence circle. It should, however, be noted that Canter and Larkin (1993) never proposed that the centre of the circle be used as a means of predicting the likely location of an offender's home, and so the fact that it performed less efficiently than the other methods is perhaps unsurprising. In fact, the $RP_{(f)}$ produced by the centre of the circle prioritization method can be viewed as a control, against which to compare the performance of each of the other methods, highlighting the operational power of each.

There are many possible developments implied by the procedures explored here. Most notably, it may be possible to combine procedures to increase effectiveness. For example, would there be any benefit from weighting the additive calculations in Dragnet or when producing the centroid by the order in which the crimes occurred, or even biasing them in relation to the broader area the crimes cover, as indicated by the Circle Hypothesis. Procedures that go beyond the dots on the map to consider land use and travel patterns are also likely to increase the effectiveness of these procedures, as well as the likely differences between types of offending.

Despite being relatively efficient at prioritizing the search for an offender and thus potentially of great value to the investigative process, Canter (2005) observes that geographical profiling is limited in application by many practical factors. One such example may be the concern of possible 'false identifications' in relation to the number of correct 'hits.' So, although offenders featuring in the top 5% of ranked prioritizations in the majority of cases have been taken to be indicative of an effective geographical profiling method in the present example, this still includes a number of people who may be needlessly troubled because of their innocence. This could be a matter of real police concern, say, because of its implications for police–public relations. However, the $RP_{(f)}$ could be used to limit the search to only those high up on the priority list.

These practical concerns show how important it is to develop our understanding of the processes on which geographical profiling are built, so that improvements are generated by richer models. As Canter (2003) argues, in order to develop and refine methods of predicting home locations there is a need for a more thorough understanding of offender's decision processes:

> Geographical profiling is not a distinct process, but rather a set of hypotheses about patterns in criminal cognitions and actions. Consequently, limits in the effectiveness of geographical profiling methods might more productively be regarded as areas in which hypotheses need to be developed of the reasons for the limitations of current strategies and systems. (Canter, 2003, p. 8)

Essentially, research needs to specify and account for measurable influences on criminal actions and to incorporate these into more comprehensive models of offending spatial behaviour. This, in turn, will enhance the accuracy with which they characterize the geographical activity of criminal populations and, consequently, such models, when applied as methods of geographical profiling and used to prioritize offenders, should prove more robust and valuable within the investigative domain.

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