Check for updates

Article

International Journal of Police Science & Management

Geographic profiling survey: A preliminary examination of geographic profilers' views and experiences

International Journal of Police Science & Management
2016, Vol. 18(1) 3–12
© The Author(s) 2015
Reprints and permission:
sagepub.co.uk/journalsPermissions.nav
DOI: 10.1177/1461355715621070
psm.sagepub.com
SAGE

Karla Emeno
University of Ontario Institute of Technology, Canada

Craig Bennell
Carleton University, Canada

Brent Snook
Memorial University, Canada

Paul J Taylor
Lancaster University, UK

Abstract
Geographic profiling (GP) is an investigative technique that involves predicting a serial offender's home location (or some other anchor point) based on where he or she committed a crime. Although the use of GP in police investigations appears to be on the rise, little is known about the procedure and how it is used. To examine these issues, a survey was distributed internationally to police professionals who have contributed GP advice to police investigations. The survey consisted of questions designed to assess: (a) how geographic profiles are constructed, (b) the perceived usefulness and accuracy of GP, (c) whether core GP conditions are examined before profiles are constructed, and (d) the types of cases in which GP is used. The results suggest that geographic profiles are commonly used in operational settings for a wide range of crime types. This appears to be true even when GP conditions are violated. In addition, general perceptions of GP accuracy and usefulness appear to be high, but this is particularly true for respondents who use computerized GP systems (compared with spatial distribution strategies, such as centroids, or educated guesses). Computerized GP systems are also the most commonly used GP approach among our respondents, especially for those who have received formal training in GP. Although preliminary in nature, the results from this study help enhance understanding of how GP is used in police investigations around the world, and under what conditions. The survey also provides directions for future research.

Keywords
Geographic profiling, serial offenders, crime investigation, serial crime, investigative psychology

Submitted 12 Nov 2015, accepted 13 Nov 2015

Introduction

Geographic profiling (GP) is "a criminal investigative methodology that analyses the locations of a connected series of crime (sic) to determine the most probable area of offender residence" (Rossmo, 2012: 144). Although there are many different ways in which GP can be used to aid in the investigation of serial crime, it is often relied

Corresponding author:
Karla Emeno, Faculty of Social Science and Humanities, University of Ontario Institute of Technology, 2000 Simcoe St N, Oshawa, ON L1H 7K4, Canada.
Email: karla.emeno@uoit.ca

on as a tool for prioritizing potential suspects, with those suspects living closest to the predicted home location being focused on first (Rossmo, 2000). Although the use of GP in police investigations appears to be on the rise, little is known about the GP procedure and how it is used in operational settings.

Predicting home locations

Although there are many different strategies available for conducting GP, most of them rely on the same two theoretical assumptions: (a) most serial offenders do not travel far from their home location to commit their crimes (distance decay), and (b) most serial offenders live within the area covered by their criminal activity (domocentricity) (Snook et al., 2002). The various GP strategies in existence can be broadly classified as either spatial distribution strategies or probability distance strategies (Snook, Zito et al., 2005). Spatial distribution strategies involve using the distribution of crime site locations to calculate a central location, which serves as the offender's predicted residence. Examples of spatial distribution strategies include the calculation of the centroid, the center of the circle (the diameter of which is defined by the two crimes in an offender's series that are farthest apart) and the center of minimum distance (Snook, Zito et al., 2005). The centroid is one of the most commonly used spatial distribution strategies with the predicted location being where the mean of the *x*- and *y*-coordinates is located.

Probability distance strategies, by contrast, predict the offender's residence by applying a mathematical function (e.g., linear, lognormal, truncated negative exponential) to each of the crime sites in the linked series. The overlapping functions produce a probability surface that specifies how likely it is that the offender resides in each of the possible areas within his or her criminal activity space (Snook, Zito et al., 2005). This surface can then be searched in a systematic fashion for the offender's residence (e.g., searching for the offender's home by starting at the location with the highest probability and ending with the location with the lowest probability). The use of computerized systems that rely on probability distance strategies (e.g., *Rigel*, *CrimeStat*, *Dragnet*) appears to be the most common way of conducting GP currently (Snook, Zito et al., 2005).

Accuracy

Much research assessing the accuracy of various GP approaches has been conducted. Rossmo (2000), for example, used information from selected FBI serial murder cases to evaluate a computerized system known as *Rigel* and found a mean hit score percentage of 6% (i.e., on average, only 6% of the total prioritized search area had to be searched before the offender's home location was found). Similarly, Canter et al. (2000) examined the computerized system known as *Dragnet* by using body disposal locations of 79 American serial killers and found an average hit score percentage across the sample of 11%.

Other research has compared the accuracy of simpler spatial distribution strategies with that of more complex probability distance strategies. For example, Snook, Zito et al. (2005) rated 11 different GP strategies (six spatial distribution and five probability distance strategies) in terms of their complexity (measured by number of computational steps required to calculate a predicted home location) and assessed their accuracy using crime data from 16 UK serial burglars. They found that strategy complexity was not correlated with accuracy, suggesting that complex GP strategies are not necessarily better than simpler strategies. In another study, Paulsen (2006a) compared several GP systems (*Rigel*, *Dragnet*, *CrimeStat*) with spatial distribution strategies using crime series of various types and found that the more complex probability strategies did not generate substantially more accurate geographic profiles than the simple spatial distribution strategies.

Finally, several studies have been conducted to examine whether clinical (i.e., human-based) forms of GP are as effective as more complex (i.e., computer-based) forms of GP (Bennell, Snook et al., 2007; Paulsen, 2006b; Snook et al., 2002, 2004; Taylor et al., 2009). Bennell, Taylor and Snook (2007) conducted a review of this research and found that training participants in simple GP strategies (i.e., heuristic training) resulted in significantly more accurate predictions. In addition, this training often, but not always, allowed human judges to perform as well on GP tasks as a range of computer-based forms of GP.

This latter finding (i.e., that human judges can perform as well as computer-based GP systems) has been hotly debated (Canter, 2005; Rossmo, 2005a; Snook, Taylor and Bennell, 2005). Much of the debate rests on the fact that the finding was established using error distance as the measure of GP accuracy. Recall that "hit score percentage" refers to the percentage of an area (produced by a GP system) that has to be searched (when working from the highest to the lowest probability point) before the offender's home base is located. "Error distance", however, refers to the distance between the highest probability point produced by a GP technique, which marks the offender's likely home location, and the location of the offender's actual residence. Critics of the research focusing on human judges have argued that error distance is not a statistically sound measure of GP accuracy and that the use of hit score percentage better reflects how geographic profiles are used in police investigations (Rossmo, 2011). By contrast, users of error distance have pointed out that it can be easily calculated and readily applied to all methods of GP, including those that do not produce search areas (i.e., strategies that result

in a single prediction point; Snook, Zito et al., 2005). Both measures have been recommended for use in a National Institute of Justice funded proposal of how to evaluate GP systems (Rich and Shively, 2004), although this recommendation has also been debated by individuals working within this field (Levine, 2005; Rossmo, 2005b).

Conditions

According to Rossmo (2000, 2005a), GP is only feasible when the following five conditions are met:

1. the offender has committed a minimum of five crimes,
2. the crimes are linked to the same offender and the series is relatively complete,
3. the offender committing the crimes has not commuted into the area of criminal activity,
4. the offender has not moved anchor points (or operated from multiple anchor points) during his or her crime series, and
5. the distribution of suitable targets (i.e., the target backcloth) is relatively uniform around the offender's home.

It is often challenging to determine whether all of these conditions have been met at the time of the investigation. For example, consider the task of deciding whether the offender is a commuter or a marauder. Marauders can be described as those offenders whose home location (or anchor point) is within their area of criminal activity, whereas commuters commit their crimes in a different area from their home (Canter and Larkin, 1993). Paulsen (2007) found the "best guess" rate of commuter/marauder predictions to be 60%, which suggests that accurate commuter/marauder predictions may not be possible at the time of the investigation. However, prediction accuracy did increase to 81% when designated predictor variables, which were all known or could be calculated at the time of the investigation, were used. The three significant predictor variables were all geographic or temporal in nature. By contrast, the traditional modus operandi-related variables (e.g., victim type, crime type and night-time activity), which are more readily available at the time of the investigation, were not significant predictors of commuter/marauder classification.

In addition, these conditions have not always been met in previous GP research. For example, studies examining GP accuracy have often included offenders who have committed a minimum of only three crimes (Paulsen, 2006a; Snook et al., 2004). As well, many GP accuracy studies have included both commuters and marauders in their analyses (Canter et al., 2000; Paulsen, 2006b). Rossmo (2005a) suggests that these GP studies bear little resemblance to actual police investigations, emphasizing the need for research examining the GP procedure and how it is used in operational settings.

Crime types

Although originally developed for the investigation of serial murder, GP has subsequently been applied to numerous other serial crime types, such as rape, arson, robbery, bombings, burglary, fraud, auto theft, and kidnappings (Rossmo, 2012). However, research suggests that GP accuracy can be expected to vary depending on the crime type to which it is applied. For example, in Paulsen's (2006a) study where the accuracy of several GP systems was compared with that of spatial distribution strategies, he found that crime type did indeed influence the accuracy of the GP profile, regardless of what GP profiling strategy was used. Specifically, certain crime types (auto theft, street robbery, and residential burglary) yielded substantially more accurate results than other crime types (commercial robbery and larceny). In addition, findings from other research suggest that offenders of interpersonal crime are more likely to be marauders than offenders of property crime (Canter and Larkin, 1993; Kocsis and Irwin, 1997; Santtila et al., 2007). Given that GP is most likely to be accurate when applied to marauding offenders, it can be expected that GP will be more accurate when applied to interpersonal crimes than when applied to property crimes.

The current study

Little is known about the GP procedure and how it is used in operational settings. The goal of the current study is to examine the use of GP in operational settings by collecting survey responses from geographic profilers around the world. The current research is exploratory, allowing for a preliminary examination of real-world geographic profilers' views and experiences of GP.

Method

SurveyMonkey® was used to create an online survey that was distributed to police professionals in Canada, the USA, the UK, Germany, Australia, Japan, the Netherlands, and South Africa, who have personally generated a geographic profile in order to assist with a police investigation (this was assessed via self-report). Recruitment for participants involved direct contact with colleagues and GP researchers, contact through various police and crime-mapping electronic mailing lists and online discussion groups, and contact through word of mouth at police-related conferences. The recruitment message described the study, the survey, and the requirements to participate. The recruitment

message also included a link to the online survey with the survey remaining available for completion for 10 consecutive months (September 15, 2011 to July 15, 2012).

Survey

The survey, which was developed by the authors, required ~ 20–30 minutes to complete and contained a total of 47 questions that were primarily closed (i.e., multiple choice) and were designed to assess:

1. how geographic profiles are constructed,
2. the perceived usefulness and accuracy of GP,
3. whether core GP conditions are examined before profiles are constructed, and
4. the types of cases where GP is used.

Although the survey consisted of 47 questions in total, the exact number of completed questions varied across the respondents depending on their answers to the branching questions (e.g., if a respondent answered "No" to having received training in GP then they automatically skipped the follow-up question where they were asked to specify the type of training received, thus reducing the total number of questions answered). A copy of the complete survey is available upon request from the first author.

Sample

Thirty-five individuals began the online survey. However, four were excluded from completing the survey because they had not personally generated a geographic profile in order to assist with a police investigation, which was a requirement for participation in the study. An additional nine respondents abandoned the survey midway through and as a result, their partial responses were also excluded from the analysis. The final sample for the current study consisted of 22 individuals (16 males, 6 females) who had personally constructed a geographic profile (mean age = 44.6 years, $SD = 9.2$; age range = 29–65). Fifteen of these individuals worked for a police department, with another two having some background experience in policing. The remaining five participants were professors, researchers, and/or psychologists with no background experience in policing. Almost three-quarters of respondents (73%) worked in North America (USA $n = 9$, Canada $n = 7$) with the remainder working in the UK ($n = 2$), South Africa ($n = 2$), the Netherlands ($n = 1$), and Italy ($n = 1$). The level of experience in generating geographic profiles varied greatly within the sample with a little over half of respondents (55%, $n = 12$) having generated 10 or fewer, 18% ($n = 4$) having generated between 11 and 20, one respondent having generated ~ 70, and 14% ($n = 3$) having generated 100 or more; two participants did not respond to this question. In addition, 77% of respondents ($n = 17$) had some form of GP training.

Given the method of survey dissemination (i.e., survey link sent out to an unknown number of potential participants via electronic mailing lists, online discussion groups, and email), it is not possible to determine an exact response rate. However, the small sample size ($N = 22$) suggests that the response rate was low, which is certainly not uncommon in research surveying police personnel. Burrell and Bull (2011), for example, surveyed 72 crime analysts in order to examine their views and experiences of comparative case analysis and reported that only 18 responded, for a response rate of 25%. In another study, Jamel et al. (2008) investigated specialist police service provided to male rape survivors by sending surveys to 300 officers and received just 19 responses (response rate = 6.3%). Although it is recognized that the findings of this research will not necessarily be generalizable to all geographic profilers working in operational settings, recall that the purpose of this study was to offer a preliminary examination of real-world geographic profilers' views and experiences of GP. Consequently, it was decided that the current, albeit small, sample was sufficient for achieving the primary aims of this research.

Analysis

Given the small sample size ($N = 22$), the survey data are examined primarily in terms of descriptive analyses, such as frequencies and means, across each of the four themes. Although survey non-completers were removed from the analyses, respondents were permitted to skip (i.e., not respond to) questions. In addition, not all questions were relevant to all respondents. As a result, the total number of responses varied by question.

Results

Predicting home locations

The vast majority of respondents indicated that they typically or always construct a GP individually (91%, $n = 20$) rather than in a group (9%, $n = 2$). In terms of the GP methods used to generate geographic profiles, 77% reported that they had used computerized GP systems ($n = 17$), followed by spatial analysis techniques and educated guesses (e.g., eyeballing a map and estimating an anchor point) with both having been used by 27% of respondents ($n = 6$).

There were some interesting differences among those respondents who had received GP training compared with those who had not (recall that 77% of respondents, $n = 17$, had some form of GP training). Specifically, a greater proportion of trained respondents (94%, $n = 16$) had used

computerized GP systems to generate a profile than untrained respondents (20%, $n = 1$). In addition, a greater proportion of untrained respondents (60%, $n = 3$) reported having used an educated guess to generate a geographic profile compared with the trained respondents (17.6%, $n = 3$).

Among the 17 trained and untrained respondents who had used computerized GP systems, *Rigel* was the most popular at 53% ($n = 9$), followed by *CrimeStat* at 47% ($n = 8$), and *Dragnet* at 18% ($n = 3$). Of the six respondents who had used spatial analysis techniques to generate a geographic profile, the center of the circle was the most popular (67%, $n = 4$), followed by the median (50%, $n = 3$), centroid (50%, $n = 3$), and center of minimum distance (50%, $n = 3$). Respondents reported having used a variety of information sources to generate their geographic profiles with crime site locations being the most commonly cited (73%, $n = 16$) (see Figure 1 for frequencies of the additional information sources used). GP has most frequently been implemented as an investigative tool by increasing patrol intensity in the area where the offender might live or work (77% for both, $n = 17$) (see Table 1 for frequencies of the additional uses of GP as an investigative tool).

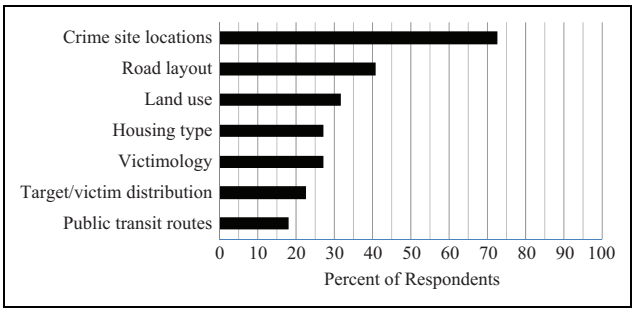

Figure 1. Information sources used to generate geographic profiles.

Table 1. Response frequencies for how geographic profiling has been implemented as an investigative tool (total $N = 22$).

Implementation	Frequency (*n*)	%
Increase patrol intensity in the area where the offender might live or work	17	77.3
Limit the suspect pool	14	63.6
Provide a starting area for door-to-door canvassing	13	59.1
Generate new tips by broadcasting the prioritized search area to the public	8	36.4
Identify an area for mass mail outs	5	22.7
Help determine probable body dump sites	3	13.6
Identify areas for DNA testing	3	13.6
Serve as evidence to help obtain a search or arrest warrant	2	9.1
Other	2	9.1

Perceived accuracy/usefulness

On average, respondents reported GP to be useful in moving the investigation forward in approximately half of the cases where it was used ($M = 53.2\%$ of cases, $SD = 28.4$). Computerized GP systems were ranked the highest with 75% of respondents ranking these systems as producing both the most accurate and operationally useful profiles. Spatial analysis techniques were ranked second by 70% and 60% of respondents in terms of producing the most accurate and operationally useful profiles, respectively. In comparison with the other two methods, 76% and 80% of respondents ranked an educated guess as producing the least accurate and least useful profiles, respectively. Approximately three-quarters of respondents (77%, $n = 17$) indicated that training should be required for individuals constructing geographic profiles. Almost all of the respondents (91%, $n = 20$) would consider constructing a geographic profile again in the future and all respondents ($n = 22$) reported that they would consider using GP as an investigative tool again in the future.

Conditions

Recall that Rossmo's (2000) five conditions of GP are: (1) the offender has committed a minimum of five crimes, (2) the crimes are linked to the same offender and the series is relatively complete, (3) the offender committing the crimes has not commuted into the area of criminal activity, (4) the offender has not moved anchor points (or operated from multiple anchor points) during his or her crime series, and (5) the distribution of suitable targets (i.e., the target backcloth) is relatively uniform around the offender's home. Figure 2 compares the percent of respondents who only use GP if a particular condition is met to those who use GP even if the condition is violated. Note that for conditions 3, 4, and 5, the gray bar consists of both those respondents who do not attempt to determine whether the offender is a commuter, the offender has moved anchor points, or the target backcloth is uniform prior to constructing the GP profile, as well as those respondents who do attempt to determine those things, but still use GP even if the condition is violated. Note that condition 2 is not included in Figure 2 because it was not assessed using a closed yes/no question.

With respect to condition 2, the results suggest that respondents had to be fairly positive that the same offender committed the series of crimes under investigation before they would use GP ($M = 74.1\%$ positive that the series of crimes was committed by the same offender, $SD = 21.3$). The majority of respondents reported that they would check with neighboring police forces to see whether they had crimes that could potentially be linked to the same

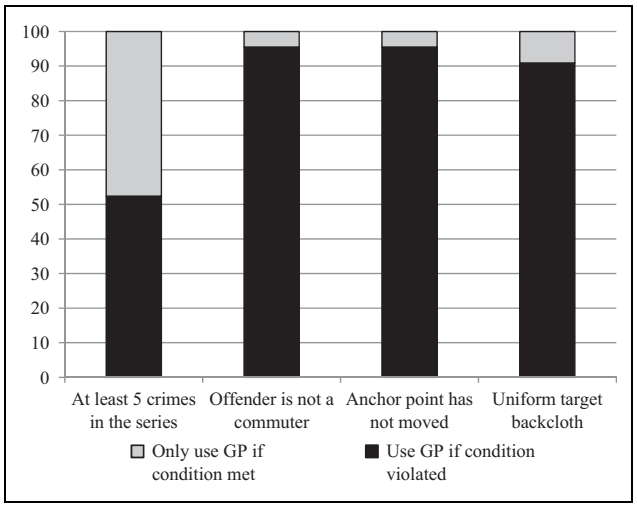

Figure 2. Graph comparing percentage of respondents who use geographic profiling if various conditions are violated with those who do not.

offender prior to constructing the geographic profile (65%, $n = 13$) or that they already had access to crimes committed in nearby areas so contacting neighboring police forces was unnecessary (25%, $n = 5$). These results suggest that respondents took steps to ensure that the crime series was relatively complete and that the crimes were linked to the same offender. However, it is still possible that GP is used in operational settings when condition 2 is violated given that it is not always possible to determine at the time of the investigation whether the series is complete and whether all crimes in the series were committed by the same offender.

In regard to the remaining four GP conditions, Figure 2 indicates that the majority of respondents still use GP even when these conditions are not met. This is particularly the case for conditions 3, 4, and 5 where 96%, 96%, and 91%, respectively, reported that they still use GP even if that particular condition is violated. The sample was more split over condition 1, with 48% reporting that they only construct a geographic profile if there are at least five crimes in the series, compared with 52% reporting that they use GP even if there are fewer than five crimes in the series. When broken down by GP training, a greater proportion of trained respondents (56.3%, $n = 9$) would only use GP if there were a minimum of five crimes in the series than untrained respondents (20%, $n = 1$).

Crime types

Many respondents reported using GP to generate profiles for a variety of crime types, such as burglary (59.1%, $n = 13$), robbery (50%, $n = 11$), murder (36.4%, $n = 8$), auto theft (31.8%, $n = 7$), rape (31.8%, $n = 7$), and arson (27.3%, $n = 6$). Approximately one-third of respondents (31.8%, $n = 7$) used GP most often in murder cases followed by burglary and robbery (both at 22.7%, $n = 5$). Table 2 contains the frequencies for all crime types included in the survey. The majority of respondents (68%, $n = 15$) indicated that they used GP in cases where the crime series contains more than one crime type. The factor cited most commonly for increasing the likelihood of GP being used as an investigative tool was a large crime series (86.4%, $n = 19$) and the officer in charge of the investigation thinking that GP would be useful (81.8%, $n = 18$) (see Table 3 for additional factors and associated frequencies).

Discussion

Although the results from the current study are only preliminary, they begin to enhance our understanding of how GP is used in police investigations around the world, and under what conditions. For example, the findings indicate that computerized GP systems are the most popular method of generating geographic profiles, at least among our survey respondents. Training in how to predict home locations was also common, with approximately three-quarters of respondents indicating that they had received formal training in GP.

Interestingly, a greater proportion of trained (versus untrained) respondents had generated profiles using computerized GP systems. This finding could speak to the specific positions held by these respondents. For example, they may be employed in positions (e.g., within police agencies) where formal training is offered (or required) and where computerized GP systems are available for use. Alternatively, this finding might simply suggest that geographic profilers are more likely to receive training on how to use computerized GP programs rather than other procedures for carrying out GP (e.g., spatial distribution techniques).

Although the largest percentage of respondents has used GP in burglary cases, they reported using GP most often in murder cases. In addition, the majority of respondents indicated that they would use GP in cases in which the crime series contains more than one crime type (e.g., burglary and armed robbery). Although further research needs to be conducted to examine the feasibility of using GP on versatile offenders, preliminary research suggests that the inclusion of multiple crime types in a series does not negatively impact GP accuracy, and can even result in more accurate and precise profiles (Leitner and Kent, 2009).

The results also indicate that geographic profiles are frequently generated even when GP conditions are violated. Specifically, GP appears to be used in investigative settings even when the crime series contains fewer than five crimes, the offender may be a commuter, the offender may have moved anchor points during the crime series, and the distribution of suitable targets is non-uniform around the

Table 2. Response frequencies for crime types where geographic profiles have been generated (total $N = 22$).

	Have used GP		Have used GP most often	
Crime type	Frequency (*n*)	%	Frequency (*n*)	%
Burglary	13	59.1	5	22.7
Robbery	11	50.0	5	22.7
Murder	8	36.4	7	31.8
Auto theft	7	31.8	1	4.5
Rape	7	31.8	1	4.5
Arson	6	27.3	0	0
Theft from motor vehicle	3	13.6	2	9.1
Bombings	2	9.1	1	4.5
Shoplifting	2	9.1	0	0
Kidnapping	1	4.5	0	0

Table 3. Response frequencies for factors associated with increased likelihood of geographic profiling being used as an investigative tool (total $N = 22$).

Factor	Frequency (*n*)	%
Crime series is long (five or more crimes)	19	86.4
Officer in charge of investigation thinks GP would be useful	18	81.8
More severe crimes were committed	12	54.5
Other investigative leads are not available or are scarce	11	50.0
GP software is readily available	11	50.0
High degree of pressure to solve the crime series	10	45.5
Crime series has been unsolved for a long period	10	45.5
Interpersonal crimes were committed	8	36.4
Property crimes were committed	6	27.3

offender's home. There are various ways to interpret the finding that respondents commonly generate geographic profiles even when GP conditions are violated, and each interpretation has different implications. First, respondents could have inappropriately used GP in problematic cases when they should not have done so, which points to a training issue. Second, respondents could have taken a calculated risk and knowingly used GP in problematic cases, resulting in a geographic profile that was potentially helpful, but not as accurate as it would have been if the conditions had been met. In other words, accuracy might have been knowingly sacrificed in order to use GP in more cases (i.e., cases where the conditions were not met). Third, respondents used GP in problematic cases and found an effective way to manage the violated condition(s) (see Rossmo and Velarde, 2008). Such an approach would highlight the importance of sharing best practices in managing the violation of GP conditions. Regardless of the interpretation, this finding indicates that assessing GP accuracy using crime data where one or more of the GP conditions are violated may actually provide a more realistic assessment of real-world GP accuracy. This is in contrast to Rossmo's (2005a) suggestion that GP studies that rely on crime data where these conditions are violated bear little resemblance to actual police investigations.

Our results also suggest that perceptions of GP accuracy and usefulness were mostly positive among the sample, with almost all respondents agreeing that they would construct and use geographic profiles as an investigative tool again in the future. Computerized GP systems were used most frequently and were considered to produce the most accurate and useful profiles in comparison with spatial analysis techniques and educated guesses. This finding is interesting given research cited previously (using error distance as the measure of performance), which suggests that simple GP strategies, such as the use of simple heuristics and spatial distribution methods, can often make GP predictions that are just as accurate as more complex procedures, such as computerized GP systems (Bennell, Snook et al., 2007; Paulsen 2006a; Snook et al., 2004; Taylor et al., 2009). This pattern of responding might reflect biases among our respondents, whereby they favor computerized GP systems even though they should not. Alternatively, as we allude to above, this might speak to the inappropriate use of error distance in evaluation research (i.e., error distance does not allow research to reveal the superior

performance of computerized GP systems; Rossmo, 2005b) or a lack of knowledge about this research. Although we are unable to determine which of these arguments have merit, it is important to point out that only a quarter of our survey respondents reported having used educated guesses or spatial analysis techniques to generate GP profiles; thus, three-quarters of respondents have never had the opportunity to directly compare the accuracy of computerized GP techniques with those of non-computerized approaches in operational settings.

Limitations and future research

Our small sample size indicates that participant recruitment was an issue. As of 2012, over 600 people worldwide had been trained using a two-week geographic profiling analysis course that is available through various universities and police agencies internationally (Rossmo, 2012). It appears that the current study was unsuccessful at reaching those individuals (assuming all were active geographic profiling practitioners at the time of this study), despite the multiple methods of survey dissemination (i.e., word of mouth, email, online discussion groups, electronic mailing lists) and frequent survey reminder messages. Another problem was the non-completion rate in the current study. Thirty-one individuals who met the participation requirements began the survey, but only 22 completed it. This represents a 29% dropout rate. The small sample size potentially limits the generalizability of our findings. It also limited the types of statistical analyses that could be conducted. For example, it was not possible for us to conduct meaningful analyses to determine how various factors, such as police experience, level of GP training, or geographic region influenced GP practices or their perceived usefulness and accuracy.

There are at least two obvious explanations for the recruitment issues we faced, and the reasonably high drop-out rate. These should be taken into account by researchers who plan to conduct similar surveys. First, the length of our survey may have been an issue for potential participants, or for individuals who began our survey, but then dropped out. Our survey was quite long, containing up to 47 questions depending on the answers given, with some of these questions requiring open-ended responses. Long surveys often decrease initial willingness to participate in a study and decreased completion rates (Galesic and Bosnjak, 2009), presumably because they increase the opportunity for respondents to lose motivation or become distracted (e.g., by time pressure or other tasks at work), and for technical problems to occur (Roßmann et al., 2015). A more streamlined version of the survey may allow future researchers to increase the sample size and completion rate without the loss of valuable information.

Second, our survey may not have asked the sorts of questions that compelled professional geographic profilers to participate in our study (or to complete the survey once they began). Given this possibility, it may be useful in the future to first conduct focus groups with geographic profilers to identify survey questions that they perceive as useful (e.g., questions that fill important knowledge gaps and move the field forward). It may also be useful to investigate similar issues with relevant professional associations (e.g., International Association of Crime Analysis, International Criminal Investigative Analysis Fellowship). Obtaining the support of relevant professional associations may also open doors for greater access to participants.

In addition to sample size issues, there are also limitations associated with the survey itself (beyond its length). For example, it is important to highlight the fact that the GP survey used in the current study was self-report in nature. As with any research relying on self-report data, there was the potential for participants in this study to be deceptive in their responses (e.g., stating that they had previously contributed GP advice to police investigations when they had not). There were also some issues with certain questions in our survey. For example, although we asked participants if they would still use GP even if Rossmo's conditions were violated, we did not ask if they have found that violating these conditions impacted the quality of the geographic profile produced. A future survey could include a question such as this in order to determine whether profiles violating the conditions are actually perceived as less useful in practice than those not violating those conditions. Greater interactions with geographic profilers (and relevant professional associations) during the survey construction phase will increase the chance that researchers ask pertinent questions in future surveys.

Conclusion

Despite the above limitations, our survey provides a preliminary examination of geographic profilers' views and experiences of GP. The results from the current study suggest that geographic profiles are commonly used in operational settings even when GP conditions are violated. In addition, computerized GP systems are viewed as the most accurate and useful, and are used most frequently. We also found that perceptions of GP accuracy and usefulness are positive with all respondents indicating that they would use GP in the future. Given that these results suggest that police departments will continue using GP as an investigative tool, further research of effective uses of GP appears to be warranted and useful from an operational standpoint. Thus, although these findings are preliminary in nature and more research is needed, particularly with larger sample sizes, they do begin to enhance our understanding of how

GP is used in police investigations around the world, and under what conditions.

Acknowledgements

Special thanks to the reviewers of the initial draft of this paper for their valuable feedback.

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

References

Bennell C, Snook B, Taylor PJ, Corey S and Keyton J (2007) It's no riddle, choose the middle: the effect of number of crimes and topographical detail on police officer predictions of serial burglars' home locations. *Criminal Justice and Behavior* 34: 119–132.

Bennell C, Taylor PJ and Snook B (2007) Clinical versus actuarial geographic profiling strategies: a review of the research. *Police Practice and Research* 8: 335–345.

Burrell A and Bull R (2011) A preliminary examination of crime analysts' views and experiences of comparative case analysis. *International Journal of Police Science and Management* 13: 2–15.

Canter DV (2005) Confusing operational predicaments and cognitive explorations: comments on Rossmo and Snook et al. *Applied Cognitive Psychology* 19: 663–668.

Canter DV, Coffey T, Huntley M and Missen C (2000) Predicting serial killers' home base using a decision support system. *Journal of Quantitative Criminology* 16: 457–477.

Canter DV and Larkin P (1993) The environmental range of serial rapists. *Journal of Environmental Psychology* 13: 63–69.

Galesic M and Bosnjak M (2009) Effects of questionnaire length on participation and indicators of response quality in a web survey. *Public Opinion Quarterly* 73: 349–360.

Jamel J, Bull R and Sheridan L (2008) An investigation of the specialist police service provided to male rape survivors. *International Journal of Police Science and Management* 10: 486–508.

Kocsis RN and Irwin HJ (1997) An analysis of spatial patterns in serial rape, arson, and burglary: the utility of the Circle Theory of environmental range for psychological profiling. *Psychiatry, Psychology and Law* 4: 195–206.

Leitner M and Kent J (2009) Bayesian journey-to-crime modeling of single and multiple crime-type series in Baltimore, MD. *Journal of Investigative Psychology and Offender Profiling* 6: 213–236.

Levine N (2005) The evaluation of geographic profiling software: response to Kim Rossmo's critique of the NIJ methodology. Available at http://www.nedlevine.com/Response%20to%20Kim%20Rossmo%20Critique%20of%20the%20GP%20Evaluation%20Methodology.May%208%202005.doc (accessed 30 October 2015).

Paulsen DJ (2006a) Connecting the dots: assessing the accuracy of geographic profiling software. *Policing: An International Journal of Police Strategies and Management* 29: 306–334.

Paulsen DJ (2006b) Human versus machine: a comparison of the accuracy of geographic profiling methods. *Journal of Investigative Psychology and Offender Profiling* 3: 77–89.

Paulsen DJ (2007) Improving geographic profiling through commuter/marauder prediction. *Police Practice and Research* 8: 347–357.

Rich T and Shively M (2004) *A methodology for evaluating geographic profiling software*. Available at http://www.ncjrs.gov/pdffiles1/nij/grants/208993.pdf (accessed 29 September 2015).

Roßmann J, Blumenstiel JE and Steinbrecher M (2015) Why do respondents break off web surveys and does it matter? Results from four follow-up surveys. *International Journal of Public Opinion Research* 27: 289–302.

Rossmo DK (2000). *Geographic Profiling*. Boca Raton, FL: CRC Press.

Rossmo DK (2005a) Geographic heuristics or shortcuts to failure?: response to Snook et al. *Applied Cognitive Psychology* 19: 651–654.

Rossmo DK (2005b) An evaluation of NIJ's evaluation methodology for geographic profiling software. Available at: http://www.txstate.edu/gii/geographic-profiling/publications/contentParagraph/01/document/Response%2Bto%2BNIJ%2BGP%2BEvaluation%2BMethodology.doc (accessed 30 October 2015).

Rossmo DK (2011) Evaluating geographic profiling. *Crime Mapping: A Journal of Research and Practice* 3: 42–65.

Rossmo DK (2012) Recent developments in geographic profiling. *Policing* 6: 144–150.

Rossmo DK and Velarde L (2008) Geographic profiling analysis: principles, methods, and applications. In Chainey S and Tompson L (eds) *Crime Mapping Case Studies: Practice and research* (pp. 35–43). Chichester, UK: Wiley.

Santtila P, Laukkanen M and Zappalà A (2007) Crime behaviours and distance travelled in homicides and rapes. *Journal of Investigative Psychology and Offender Profiling* 4: 1–15.

Snook B, Canter DV and Bennell C (2002) Predicting the home location of serial offenders: a preliminary comparison of the accuracy of human judges with a geographic profiling system. *Behavioral Sciences and the Law* 20: 109–118.

Snook B, Taylor PJ and Bennell C (2004) Geographic profiling: the fast, frugal and accurate way. *Applied Cognitive Psychology* 18: 105–121.

Snook B, Taylor PJ and Bennell C (2005) Shortcuts to geographic profiling success: a reply to Rossmo (2005). *Applied Cognitive Psychology* 19: 655–661.

Snook B, Zito M, Bennell C and Taylor PJ (2005) On the complexity and accuracy of geographic profiling strategies. *Journal of Quantitative Criminology* 21: 1–26.

Taylor PJ, Bennell C and Snook B (2009) The bounds of cognitive heuristic performance on the geographic profiling task. *Applied Cognitive Psychology* 23: 410–430.

Author biographies

Karla Emeno is Assistant Professor of Forensic Psychology in the Faculty of Social Science and Humanities at the University of Ontario Institute of Technology, Oshawa, Canada. Her research has primarily examined investigative and crime prevention techniques, such as geographic profiling, space–time clustering of crime, and predictive crime mapping. Recent and upcoming research projects also focus on key topics in policing, including recruitment, selection, and stress.

Craig Bennell is Professor of Psychology at Carleton University, Ottawa, Canada and Director of Carleton's Police Research Lab. Much of his research examines the reliability, validity, and usefulness of psychologically based investigative techniques, including criminal and geographic profiling. Craig's other stream of research examines factors that influence police decision-making in use-of-force encounters.

Brent Snook is Professor of Psychology at Memorial University, Newfoundland and Labrador, Canada and Director of Memorial's Psychology and Law Lab. His research aims to advance scientific and legal literacy within the criminal justice system and conduct research that improves the administration of justice. Specifically, Brent's research examines the validity and reliability of various psychological-based investigative practices and decision-making within the criminal justice system.

Paul J Taylor is Professor of Psychology at Lancaster University, United Kingdom. His research focuses on how people cooperate by examining both the fundamental behavioral and cognitive processes that make human interaction possible and, more practically, the kinds of tactics and policies that promote peaceful resolutions. Paul is Director of the UK Centre for Research and Evidence on Security Threats, an independent ESRC centre with funding from the UK security and intelligence agencies.