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Commentary

Shortcuts to Geographic Profiling Success: A Reply to Rossmo (2005)

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SUMMARY

In 'Geographic profiling: The fast, frugal, and accurate way' (*Applied Cognitive Psychology*, 2004, vol. 18, pp. 105–121), we demonstrated that most people are able to predict the home location of a serial offender by using a simple prediction strategy that exploits patterns found in the offender's spatial behaviour. In this issue of *Applied Cognitive Psychology*, Rossmo challenges the validity of this research with respect to our data selection and methods of analysis. In response, we argue that: his proposed method for selecting data is unscientific; there is little evidence to support his claim that five crimes are required before profiles can be accurate; search area as a measure of profile accuracy has not yet been shown to be more useful than error distance; the heuristics we have examined are defined correctly and do lead to improvements in profile accuracy; and computerized geographic profiling is not a free service. Our comments aim to generate constraint in those intent on building confidence in computerized geographic profiling systems in the absence of strong empirical evidence to support their use. Copyright © 2005 John Wiley & Sons, Ltd.

In our article, 'Geographic profiling: The fast, frugal, and accurate way' (Snook, Taylor, & Bennell, 2004; hereafter STB), we examined human performance on a task that involves predicting where a serial offender lives based on the location of his or her crimes. Our results showed that most people were able to make accurate predictions in this task using cognitive strategies that match the structure of offenders' spatial behaviour. Even in cases where participants' initial performance was poor, we found that a short training session ensured they used appropriate strategies. In all cases, the use of these strategies by participants led to predictions that were as accurate as those made by the algorithms underlying computerized geographic profiling systems (Canter, Coffey, Huntley, & Missen, 2000; Rossmo, 2000).

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In this issue of *Applied Cognitive Psychology*, Rossmo puts forward a number of concerns about our data selection and methods of analysis, which he suggests results in our research being of little practical value. We are grateful to Rossmo for his response and take the opportunity here to briefly address his concerns. We outline why we feel his arguments do not sit comfortably with current empirical knowledge and reassert the dangers of rigidly supporting efforts to build confidence in computerized geographic profiling systems in the absence of strong empirical evidence to support their use.

CASES MUST MEET ASSUMPTIONS BEFORE THE APPROACH IS FEASIBLE?

Rossmo (2005) argues that our test of computerized geographic profiling is unfair because we examine cases that do not meet the assumptions supposedly required by geographic profiling (Rossmo, 2000). While, in principle, we see nothing wrong with restricting geographic profiling to a subset of cases, the approach proposed by Rossmo is to select cases based on four specific criteria that are only likely to be known after an offender is caught.

For example, Rossmo argues that geographic profiling is feasible only when the crimes being assessed are comprised of linked crimes, yet, there is no way of knowing for certain (with perhaps the exception of DNA evidence) during an investigation that two crimes are linked (Bennell & Canter, 2002). In addition, he argues that geographic profiling is not possible if the offender has moved residence during the period of his crimes. However, knowing an offender has moved requires that you also know where he or she has lived, which is usually enough information to circumvent the use of profiling. Furthermore, he argues that geographic profiling will only work if the offender is a ‘local hunter’ (i.e. marauder) and not a ‘poacher’ (i.e. commuter), which is unreasonable because there is currently no way of classifying an offender as a marauder or commuter before his crimes are solved. Finally, Rossmo argues that success in geographic profiling is dependent upon the offender having a uniform spatial opportunity structure (i.e. their intended targets are, to a large extent, uniformly distributed around their home location). There is currently little empirical evidence to indicate how (or even if) target backcloth influences offender spatial behaviour. To determine the influence of target backcloth, one would first need to know where the offender lived in relation to his intended targets (e.g. contrary to Rossmo’s, 2005, argument, an offender who targets prostitutes in a red light district is faced with a uniform spatial opportunity structure, if he lives in the area of the red light district).

To put it bluntly, geographic profiling is an investigative tool, and to test it using data that are selected on the basis of post-investigation criteria is not to test it at all. Instead, geographic profiling strategies must be tested under conditions that are not ideal (e.g. with commuting offenders) since these are the conditions that profilers will face in actual investigations. Only in this way can accurate measures of how well a geographic profiling strategy works be obtained.

MORE CRIME SITES ENABLE BETTER PREDICTIONS?

Rossmo (2005) argues that the accuracy of geographic profiling improves when predictions are based on more information. He specifically criticizes the fact we only used crime series consisting of three crimes in STB and argues that a minimum of five crimes are needed before computerized systems obtain a stable pattern detection (Rossmo, 2000). It appears that the evidence for this argument comes from Monte Carlo testing conducted by Rossmo (2000), in which geographic locations (representing crime sites) were randomly distributed around a point (representing an offender's home) using a distance-decay function, after which his criminal hunting algorithm (which is itself a distance-decay function) was applied to the locations to predict the original point. The use of more locations resulted in better predictions. We have several problems with this argument.

Our first problem is that we believe Rossmo's (2000) Monte Carlo testing is simply a case of regression to the mean. It is the multidimensional equivalent of randomly choosing numbers either side of a 'home' of, say, 50, and then taking the mean of those numbers. The derived mean rapidly approaches 50 as more random numbers are included, particularly when you place the additional constraint of choosing more numbers close to 50 than far away from 50 (as would be the case when adopting a distance-decay model). However, this will not necessarily occur when examining real offender data because human spatial behaviour is not random (e.g. Brantingham & Brantingham, 1981). This argument is supported by studies (e.g. D. Paulsen, paper presented at the 2nd Annual UK Crime Mapping Conference, London, 2004; Snook, Zito, Bennell, & Taylor, 2005) that have directly examined the relationship between crime series length and profiling accuracy (using real data) across a wide range of geographic profiling strategies, including computerized geographic profiling systems. Each of these studies found little evidence for a strong positive relationship between the two variables. In addition, and perhaps most importantly, the results presented by Snook, Canter, and Bennell (2002), where human judges were compared to computerized geographic profiling systems using crime series consisting of *five* crimes, correspond directly to the results presented by STB.

In addition to this concern about what Rossmo's (2000) Monte Carlo testing actually represents, we are also unclear as to why Rossmo (2005) argues for a specific threshold of five crimes. Our confusion stems from the fact that Rossmo's simulations actually show his distance decay algorithm performing at optimal levels when 17 crime site locations are used, not five (i.e. simulations consisting of 17 locations is when an obvious plateau is observed in Rossmo's accuracy measure). Perhaps Rossmo (2000) felt it would be advantageous for the police to have a threshold that did not cost so many lives, or perhaps it is rare for real serial offenders to commit 17 or more crimes. Regardless of his rationale, there seems to be no evidence to support his choice of five crimes. For example, Rossmo's (2000) analysis clearly indicates that the gain in profiling accuracy (2.5%) that occurs when using six crime site locations (as compared to five locations) is equivalent to the gain in accuracy (2.5%) that occurs when using five crime site locations (as compared to four locations). So, given this, why did Rossmo not choose six crime site locations as a threshold?

ERROR DISTANCE IS AN INAPPROPRIATE MEASURE OF PERFORMANCE?

Rather than use the straight-line distance between the predicted home location and the actual home location (i.e. error distance), Rossmo (2005) argues that the area searched before locating the offenders' home (i.e. search area) is a more accurate measure of profiling accuracy. While we agree that search area is a useful accuracy measure, there are important reasons why we have consistently opted to measure profile accuracy using error distance.

One of the primary reasons is that area-based accuracy measures are restricted to computerized geographic profiling systems, whereas error distance is a measure that can be used to evaluate the performance of various profiling strategies (Snook et al., 2005). This is because computerized profiling strategies provide the police with a prioritized area (which includes a point of highest probability) that can be searched to locate the suspect, whereas most other approaches to geographic profiling only provide a single point of highest probability.

The use of error distance also allows us to compare our results to previous research. Interestingly, Rossmo (2005) comes to the opposite conclusion. He argues that the use of error distance does not allow us to compare the results from our studies to those that have used area-based accuracy measures (e.g. Canter et al., 2000; Rossmo, 2000). However, he neglects to mention the fact that numerous studies have used error distance to measure profiling accuracy (e.g. D. Paulsen, paper presented at the 2nd Annual UK Crime Mapping Conference, London, 2004; Levine & Associates, 2000; Snook et al., 2002). Our results can of course be compared to these studies. Unfortunately, Rossmo's (2000) results cannot.

Furthermore, we believe that the single probability estimates that error distances are based on may provide a useful operational alternative to computer generated search strategies. In contrast to this opinion, Rossmo (2005) argues that the use of error distance as a measure of profile accuracy '. . . undermines the very mechanics of how the geographic profiling process works' because it is based on a single estimate of where the offender will likely live (rather than a prioritized search area). However, this argument is only valid if there is consistent evidence that the prioritized search areas produced by computerized geographic profiling systems are actually useful. This evidence does not exist. In fact, even Rossmo (2000) points out that, depending on the size of the search area, the number of potential suspects located within that area, and the resources that are available to the police, police forces may not be able to effectively search a prioritized area. A single estimate of where an offender lives provides a potentially useful alternative to this approach because it allows police forces to start their search at the point of highest probability and work their way outwards until their resources are depleted. Having said this, we cannot say with a high degree of confidence whether this procedure is more effective than computer generated search strategies. That is an empirical question that has yet to be answered.

Finally, it is important to point out that there is currently no evidence to indicate that an area-based accuracy measure is more valid than error distance. Perhaps this is one of the reasons why an expert panel on geographic profiling (organized by the US-based National Institute of Justice) recently concluded that error distance and search area are both useful measures of profiling performance (Rich & Shively, 2004).

THE USE OF INAPPROPRIATELY DEFINED HEURISTICS?

Rossmo (2005) argues that the heuristics we taught our participants do not accurately reflect what is known about offender spatial behaviour. Specifically, he suggests that our Decay heuristic would be more correct if it had been phrased, 'many offenders live close, but not too close, to their crime locations' (we defined it as 'the majority of offenders commit offences close to home'). Rossmo's argument is based on his belief that buffer zones exist around offender residences (i.e. an area close to their homes where offenders will not commit crimes). Rossmo fails to inform readers that there is little agreement on how to define or measure a buffer zone. For example, some researchers have measured buffer zones as the average distance between an offender's home and their crime site locations, while others have measured them as the distance between the home and the crime that has been committed closest to the home. Rossmo (2005) draws on the former definition and concludes that buffer zones exist. Researchers drawing on the latter definition find that offences *do* occur very close to offenders' homes and therefore conclude that buffer zones do not exist (Kocsis & Irwin, 1997; Warren et al., 1998). More importantly, research comparing the accuracy of distance decay algorithms that do and do not include a buffer zone parameter have either shown that there is no difference in accuracy (Taylor, Bennell, & Snook, 2002) or that an algorithm not including a buffer zone parameter leads to more accurate geographic profiling predictions (Canter et al., 2000).

Rossmo (2005) also suggests that our Circle heuristic should have been phrased as, 'half or more of criminals live within the circle encompassing their crime locations' (we defined it as 'the majority of offenders' homes can be located within a circle with its diameter defined by the distance between the offender's two furthermost crimes'). He then points to a number of studies that have found low percentages of offenders residing within the circle and argues that the Circle heuristic will be less valid in those environments. We agree with Rossmo that performance will decrease when the Circle heuristic is used to make predictions on a population of serial offenders where the marauding pattern is not prevalent. But, the success of *all* geographic profiling methods, whether made by a human or computer, will decrease in this scenario because all methods depend partially on offenders living within their area of criminal activity. Indeed, Rossmo (2005) states that 'the process [geographic profiling] assumes the offender's anchor point lies within the hunting area, it cannot determine the residence of poaching offenders who commute' (pp. 652). Thus, although Rossmo is aware that the prevalence of marauders in a population of offenders will effect the accuracy of profiling predictions made by humans, he appears unaware that it will have the same effect on the performance of his complex computerized geographic profiling system.

GEOGRAPHIC PROFILING IS A FREE SERVICE?

In response to our questioning of the costs associated with computerized geographic profiles, Rossmo (2000) correctly points out that law enforcement agencies in Canada, the US, and the UK are able to obtain free profiles from federal (national) law enforcement agencies. But, this does not render the service free. It simply shifts the burden of costs, time, and effort to different agencies. Nor does it help the many countries that deal with serial crime on a regular basis but do not have recourse to a federal service (e.g. South Africa) (Hodgskiss, 2004). Perhaps more important is the fact that, when a police force makes a request for a geographic profile, the profiler can spend up to 2 weeks preparing a profile (Rossmo, 2000). In investigation terms, 2 weeks is an eternity, especially if there is an equally accurate profiling approach available within minutes, that is easily implemented at little cost to the police force requiring the profile.

CONCLUSION

Geographic profilers have access to a repertoire of strategies for predicting a serial offender's home location, but have been keen to spread confidence in complex computerized strategies despite the lack of strong empirical evidence to support their use (e.g. Rossmo, 2000). Their overarching assumption is that heuristics, or cognitive short-cuts, make humans dumb. However, research has been showing that heuristics that reduce complex problems into simpler judgmental problems often leads to accurate decision-making (Gigerenzer, 2000; Gigerenzer & Selton, 2001; Gigerenzer, Todd, & The ABC Research Group, 1999; Kahneman & Tversky, 1973). One of the goals of our research programme is to identify the heuristics that people use to make geographic profiling predictions and understand when and why those heuristics succeed and fail. It seems to us that geographic profiling 'experts' who utilize computerized geographic profiling systems are providing nothing beyond what could be achieved by applying one of the two simple cognitive strategies that we have focused on in our research. We agree with Rossmo (2005) that the wrong shortcut can lead to bad investigative decisions, yet, our studies have repeatedly shown that appropriate shortcuts can result in good decisions, or at least decisions that are as accurate as computer-based predictions.

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