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Who Commits Near Repeats? A Test of the Boost Explanation

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ABSTRACT

Using techniques developed in the field of epidemiology, recent research conducted in both the UK (Johnson and Bowers 2004) and Australia (Townsley et al. 2003) demonstrates that the risk of victimisation can be treated as communicable. That is, following a burglary at one home the risk of burglary at nearby homes is amplified. This heightened risk endures for a shot period of time, typically one month. The pattern has been labelled the 'near repeat' phenomenon, and the results have clear implications for crime prevention and for the prediction of future patterns of crime. One question that has remained unanswered concerns the similarity of the Modus Operandi (MO) used in near repeat events. If similar this may suggest a common offender across a crime series. It may also allow us to increase the accuracy of attempts to predict how, as well as when and where, crime will be committed. In this paper, we compare the similarity of the MOs of near repeat and unrelated burglary events, and demonstrate that for the former the configuration of 'the means of entry' and 'point of entry' are significantly more congruent than for the latter. The implications of the results are discussed.

KEYWORDS: repeat victimization; near repeat victimization; modus operandi; offender behaviour.

Understanding patterns of criminal behaviour is important for both the prevention and detection of crime. In this paper we will focus on the crime of burglary and concentrate, in particular, on work concerned with spatial and temporal patterns of this crime. Research in this area has revealed a number of findings that have direct relevance to both policy making and operational policing. For instance, studies demonstrate that rather than being random, crime tends to cluster in space (e.g. Bailey and Gatrell 1995), and that directing police (Sherman and Weisburd 1995) or crime prevention (e.g. Kodz and Pease 2003) resources to such 'hotspots' can have a crime reductive effect. However, the areas delineated as hotspots of crime are typically large and even in areas where the risk of victimisation is high, not all households are victimised (e.g. Budd 1999). Thus, to optimise the efficiency of crime reduction effort, a more precise understanding of the dimensions of risk is needed. Research demonstrates that prior victimisation is a very good predictor of future risk (e.g. Anderson et al 1995; Polvi et al. 1990; Farrell and Pease 1993) and that when it occurs, repeat victimisation tends to occur swiftly (e.g. Polvi et al. 1991; Anderson et al. 1995; Johnson et al. 1997). The implications of such findings for crime prevention are difficult to overemphasize; the burglary event should trigger preventive action focused on the burgled home.

Interventions that have focused on reducing repeat victimisation have realized impressive reductions in crime. For instance, in the original demonstration project, which included a target hardening initiative directed towards victims of crime, relative to a reference area, burglary within the target area was reduced by up to 70% (Forrester et al 1988). Numerous replication studies have subsequently been published (e.g. Johnson et al. 2001), thereby illustrating the external validity of this approach in areas where repeat victimisation is a problem.

Two rival (or complementary) hypotheses have been articulated to account for repeat victimisation. The first, referred to as the flag account (see Pease 1998) suggests that certain properties effectively advertise their vulnerability, which attracts any passing opportunistic offender. In this way, burglaries that occur at the same location are considered to be independent events, with the only thing in common being the property targeted. According to the second hypothesis, on the other hand, a subsequent event committed at a property is considered conditional upon the first. Thus, following an initial crime, the risk of victimisation is 'boosted' (Pease 1998). Here, the assumption is that the same offender, or group of offenders, will be involved in the crime series and that experience gained during the first event is put to use later.

Determining which of these explanations is correct, or the extent to which each contributes towards an explanation of the phenomenon, has important implications for crime reduction theory and practice. For instance, if a series of crimes were usually committed by the same offender, this would aid the investigative process and increase the probability of detections. Moreover, if a particular offender favored a specific Modus Operandi (MO) which he or she applied consistently, this too would inform strategies aimed at preventing further events.

Patterns of crime provide a partial means of determining the relative importance of boost and flag explanations. For instance, according to the flag account, we would anticipate that repeat crimes would be equally likely to occur over a variety of intervals of time. Thus, the finding that incidents of repeat victimisation tend to occur swiftly (e.g. Polvi et al. 1991), which reflects an event-related signature, is difficult to reconcile with the flag account (unless the rate of victimisation of the home is so high that events occur every few weeks, which is thankfully exceptional).

Specific *a priori* predictions also can be made regarding the *way* in which repeat incidents are committed. Within the forensic psychology literature it is assumed that there will be a fairly high degree of similarity in the way in which the same offender commits a series of crimes (e.g. Bennell and Canter 2002; Ewart, Oatley and Burn 2004). For instance, a particular offender may favor a specific tool or entry point to gain access. Further evidence for this theory comes from recent work by Adderley and Musgrove (2003). They used features of Modus Operandi (including spatial and temporal preferences) to identify crimes that could potentially have been carried out by a particular network of offenders who worked together. Using the MO preferences of the network, they were able to increase the accuracy of a list of the network's possible offences from 10-15 percent to 55 percent. Taken together, these findings suggest that MO can be a useful way of distinguishing between the strategies of different offenders/networks of offenders.

If repeat crimes are committed by the same offender(s), we would expect a series of repeat events to have similar MOs. Ratcliffe and McCullagh (2001) examined the similarity of the MOs used in repeat burglaries, operationalized as the point of entry (POE, e.g. back door versus ground floor window) and means of entry (MOE, e.g. kicked in versus window smashed) used. The results indicated a greater degree of consistency for repeat crimes committed closest together in time.

Interviews with offenders provide still further support for the boost account (Pease 1998). Consideration of the reasons typically given by offenders for returning to the same properties suggests that these are bounded by rational choices that are entirely commensurate with the boost account. These include familiarity with the house layout, the risks involved, and the known availability of saleable goods (Ericsson, 1995). Thus, the overwhelming evidence from the research undertaken is that the same perpetrators are responsible for the bulk of offences against the same target (Farrell and Pease 2001).

More recent research suggests that repeat victimisation may represent a special case of a more general space-time pattern of victimisation, with implications for effective crime prevention and crime pattern theory. Specifically, research conducted in the UK (Bowers and Johnson 2005; Johnson and Bowers 2004) and Australia (Townsley et al. 2003) suggests that the risk of victimisation is communicable, with the risk of victimisation following an initial burglary not only affecting the burgled home but, in a similar way to the spread of a communicable disease, also extending to properties nearby. As with repeat victimisation conceived narrowly, the (communicated) risk of burglary to nearby properties (within 400m of each other) was shown to be elevated for a short period of time, typically one-month, after which risks returned to pre-event levels. This pattern of space-time clustering has been referred to as the 'near repeat' phenomenon to reflect the association with repeat victimisation.

Across all of the published studies (Bowers and Johnson 2005; Johnson and Bowers 2004; Townsley et al. 2003), the starting point for the research was essentially a variant of the predictions generated by the boost account. The rationale for which was that having burgled one property, offenders would become more familiar with and, consequently, target nearby households. Good reasons for this hypothesis exist. For instance, houses nearest to each other are likely to share more features that may inform offender targeting decisions than those located further away. Such features include access and escape routes, internal and external architectural layouts, levels of natural surveillance, and the availability of desirable goods. As already noted, the results of the studies validated the hypothesis, demonstrating that burglary clusters in space and time. However, one question that currently remains unanswered concerns the similarity in the way in which near repeat burglaries are committed. If similar, this would suggest a common offender or group of offenders. If substantially different, an alternative conclusion may be warranted.

The aim of the current study was to examine this issue using police recorded crime data for the County of Merseyside, UK. As with the study conducted by Ratcliffe and McCullagh (2001), two forms of MO were examined, these being point and method of entry. The specific hypothesis was that if near repeats are committed by the same offenders we would expect a greater degree of similarity in the way in which pairs of such incidents were committed than would be expected on the basis of chance. Furthermore, we also would expect there to be a greater degree of similarity for events that occurred close to each other in both space and time than for crimes which occurred close to each other on one dimension alone (close in space but not time or vice versa). The importance of the latter point warrants further emphasis as one criticism that could be directed at a set of confirmatory findings is that we might expect events that occurred close together to have similar MOs even if they were committed by unrelated offenders. The reason for this is that it is plausible that opportunities, in terms of point of entry and to some extent method of entry, may cluster in space. To illustrate this point, consider that as already discussed, houses on the same street will most probably share similar architectural features which in turn would provide similar potential opportunities for access to the houses for opportunistic offenders. However, it is important to note that we are concerned here with the similarity in the MOs for events that occur close together in both space *and* time. That is, even if specific opportunities that encourage offenders to use specific MOs cluster in space, there is no reason to anticipate that they would systematically cluster in time also.

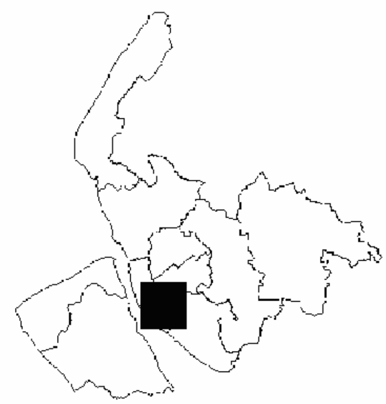
To summarise, research demonstrates that burglary clusters in space and time, placing the burgled home and those nearby at an elevated risk of victimisation in the near future. In relation to repeat victimisation proper, interviews with offenders, analyses of the temporal signature of repeat victimisation, and the similarity of MOs across successive events at the same property provide support for the boost explanation of this phenomenon. Thus, the aim of the current study is to examine whether analyses of police recorded crime data provide evidence to support the same conclusion concerning near repeats.

DATA

Police recorded crime data concerned with 3,562 domestic burglaries that occurred in a study area of Merseyside between April 1997 and March 1998 were analysed. The study area and time period selected were chosen to allow direct comparisons with our earlier work. For the purposes of illustration the study area is shown as Figure 1. For each burglary event, the data included the following fields of information:

- a unique reference number
- the address of the offence, stored as a free text field
- the grid reference of the offence location (*x* and *y* coordinates)
- the date of the offence
- the point of entry used to gain access to the property
- the method of entry used

Figure 1. Map of Merseyside and the grid used.



Measuring the Similarity of the Modus Operandi used

To address the research hypothesis, in the analyses that follow, *all* burglaries are compared with *all* others in discrete pairs. With 3,562 crime events, this means that 6,342,141 comparisons were made.

$$\left(\frac{3562*3561}{2}\right) = 6{,}342{,}141$$

For each burglary pair, the distance and time between the two events was calculated. In addition, the MOs for each event were also compared. The more MOs that are considered and match, the more confident we can be that there is a connection between the events. This is because the discriminatory power of the test increases with the number of cases considered.

On Merseyside, as in many other forces, there are several different MO fields that help to describe the burglary event. For example, MOs cover point of entry, means of entry, relationship with offender, time of offence, description of victim, description of location, and description of weapon. For each of these fields standard codes, which have an associated look up table, are used to describe how the crime was committed. When inputting data, the officer is requested to pick the most relevant fields to complete. Consequently, the frequency with which each field is completed typically varies according to the type of crime. For instance, the most frequently completed fields for burglary are point of entry, means of entry, and location of the event.

In addition to considering the reliability of the MO data, it is important to consider the relevance of the different variables in relation to the experimental hypothesis. The aim of the current research was to see how consistently different incidents of burglary were carried out within an area. Thus, as we were concerned with property crime, some MO data such as the victim's relationship with the offender, the description of the victim, and the description of any weapon used were considered less relevant[2]. Hence, as a result of data availability, reliability, and relevance, the analyses that follow are restricted to consideration of two elements of the MOs used; point of entry (available for 84% of incidents) and means of entry (available for 88 % of incidents).

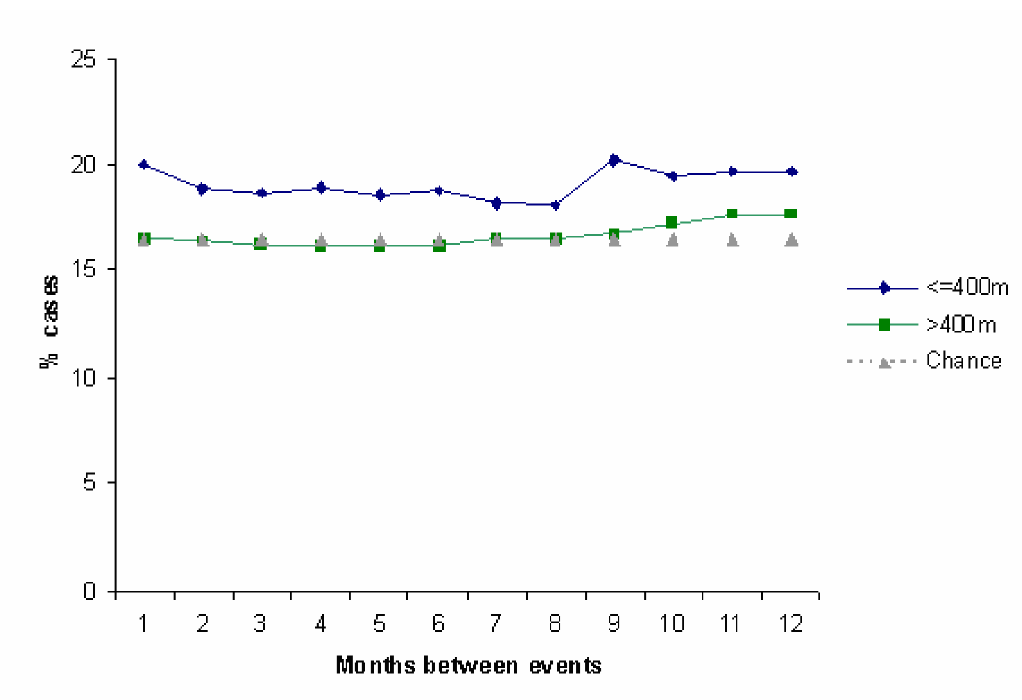
In line with earlier research (Johnson and Bowers, 2004), and in response to the findings concerned with the communicability of risk, as a starting point 'near repeats' were defined as burglaries occurring within 400m and one-month. Using these criteria, analyses were conducted to contrast the similarity of the MOs used in near repeat burglaries with those used in what, for the purposes of this research, would be considered random burglary pairs. To maintain a focus on near repeats, the analyses that follow exclude comparisons of repeat offences at the same location.

Method of Entry Used (MOE)

Figure 2 shows the proportion of burglaries for which the means of entry (MOE) was the same for pairs of burglary that were within 400 metres of each other and for those that were greater than 400 metres apart. The x axis shows the number of months elapsing between events. Figure 2 shows that for pairs of burglary events that occurred within 400m of each other, the MOE used across the two offences were the same for 17 percent to 20 percent of burglary pairings. Despite a subtle trend for burglaries that occurred within one-month of each other (20%) to be more similar to each other, no clear temporal signature is apparent. For burglaries that occurred further apart from each other, the percentage of burglary pairs for which the MOs were the same was lower across all chronometric intervals. The difference achieved statistical significance (z=3.06, p<.005, two-tailed).

To interpret the above analyses it is important to compare the observed results with what we would expect on the basis of chance. For the current analyses, the probability that two unrelated burglaries would share the same MOE can be calculated by considering the frequency with which the different MOEs were actually used. Across all offences, 42 different methods were used. The prevalence of different types of MOE varied (e.g. bodily pressure was used in 26% of cases, whereas the offender sneaked into the house in around 8% of cases), and hence it is more likely that the MOE for two unrelated events would be the same for some means of entry than for others. Using this information and applying basic statistical theory it is possible to calculate the probability (P(matched MOE)) that the MOE for two different events would match on the basis of chance. The formula is described as follows:

Figure 2. Percentage of burglary pairs for which the means of entry was the same.



$P(\text{matched MOE}) = P(MOE_1=1 \text{ and } MOE_2=1) + P(MOE_1=2 \text{ and } MOE_2=2) + ... + P(MOE_1=42 \text{ and } MOE_2=42)$

Hence,

$P(\text{matched MOE}) = P(MOE_1=1) \times P(MOE_2=1) + P(MOE_1=2) \times P(MOE_2=2) + ... + P(MOE_1=42) \times P(MOE_2=42)$

For the current data,

$P(\text{matched MOE}) = 0.165$

Considering the results shown in Figure 2, for burglary events that occurred within 400 metres of each other, the proportion (Mean = 19.1%) of burglary pairs for which the means of entry was the same for both events was slightly above the chance level. A one-sample t-test confirmed that the difference was statistically significant ($t(11)=12.32$, $p<.001$, two-tailed). For burglary pairs that were more than 400 metres apart, the equivalent proportions (Mean = 16.6%) were almost identical to the chance level ($t(11)=0.21$, $p=0.84$, two-tailed).

Point of Entry Used (POE)

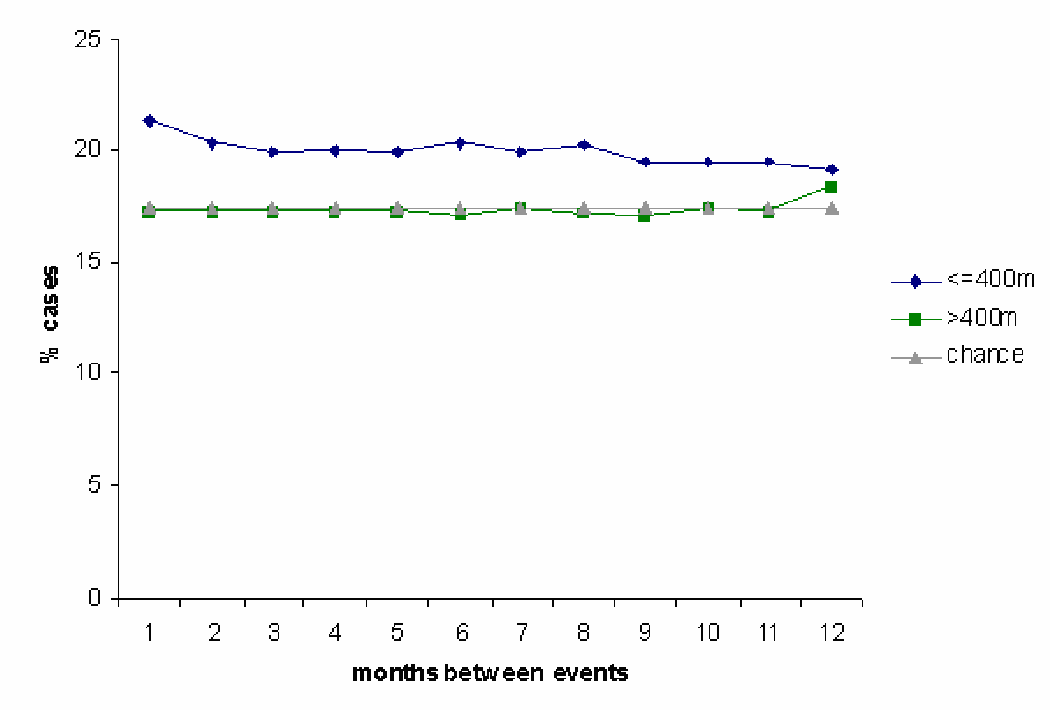
The proportion of cases for which the same POE was used in pairs of events is shown in Figure 3. The number of cases for which the POE were the same again ranged between 15 percent-20 percent, and this was consistently higher for burglaries that were nearer to each other than those further away. This difference achieved statistical significance ($z=3.06$, $p<.005$, two-tailed). Once more, there was no evidence of a distinct temporal signature in the pattern of results - the rate of matches appears to be fairly consistently independent of the time that elapsed between events. However, in line with the findings for MOE, there was a slightly larger percentage (21.3%) of near repeats (burglaries that occurred within 400m and one-month of each other) that had the same POE.

In the same way as described above, it is possible to derive an estimate of the probability that two burglary events would share the same MO on the basis of chance. For the POE used, 20 different methods were identified in the current data set. The frequency with which different points of entry varied (e.g. the front door was used in 27% of incidents, the rear window on the upper floor in 5% of cases), and hence it is more likely that the POE for two unrelated events would be the same for some entry points, such as the front door, than others. Consequently, for the current data:

$P(\text{matched POE}) = 0.174$

Thus, for burglaries that occurred within 400m of each other, the probability that the same MO in this case the

Figure 3. Percentage of Burglary pairs for which the point of entry was the same.



POE used (Mean = 20.0%), was the same for two events was, on average, above the chance level of 17.4 percent. The difference was statistically significant (t(11)=15.85, p<.005). In contrast, the probability that burglaries that occurred over 400 metres from each other (Mean =17.3%) would have the same MO did not differ from what would be expected on the basis of chance alone (t(11)=0.73, p=0.48).

Point *and* Method of Entry

The analyses reported so far have considered one aspect of MO in isolation. In this section we consider the frequency with which pairs of burglary events share *both* of the MO attributes analysed. Figure 4 shows that the percentage of cases for which both the means of entry and the point of entry matched was fairly low– varying between 5%-8%. However, to interpret this finding it is important to consider what we would expect on the basis of chance. From our earlier calculations we know that:

P(matched MOE) =0.165
P(matched POE)= 0.174

However, it is unlikely that the configuration of any two MOs will be independent. For instance, it is likely that some MOEs and POEs will go hand-in-hand (e.g. bodily pressure and a back door). For this reason, using the burglary data, an analyses was undertaken to determine the frequency with which each MOE and POE combination occurred. By doing this, it was possible to calculate the probability that for any two burglaries both the MOE and the POE would match by chance alone, accounting for variations in the co-occurrence of certain MOEs and POEs. The results indicated that the probability that any two burglaries would have the same two MOs on the basis of chance was 0.0497.

Therefore, for near repeats the frequency with which (8% of comparisons) the MOs of both events were the same was almost twice the figure we would expect on the basis of chance. Considering pairs of burglaries that occurred within 400m of each other (independent of when), a one-sample t-test confirmed that the average (Mean = 6.6%) percentage for which both MOs were the same was above the chance level (t(11)=13.12, p<.0001, two-tailed). For events that occurred greater than 400 metres apart, the percentage of pairs for which both MOs matched was not significantly different to chance (t(11)=-0.117, p=0.91, two-tailed).

Consistent with the above findings, Figure 4 illustrates that pairs of burglaries that occurred closer together were more likely to have been committed in a

Figure 4. Percentage of burglary pairs for which both Mos were the same.

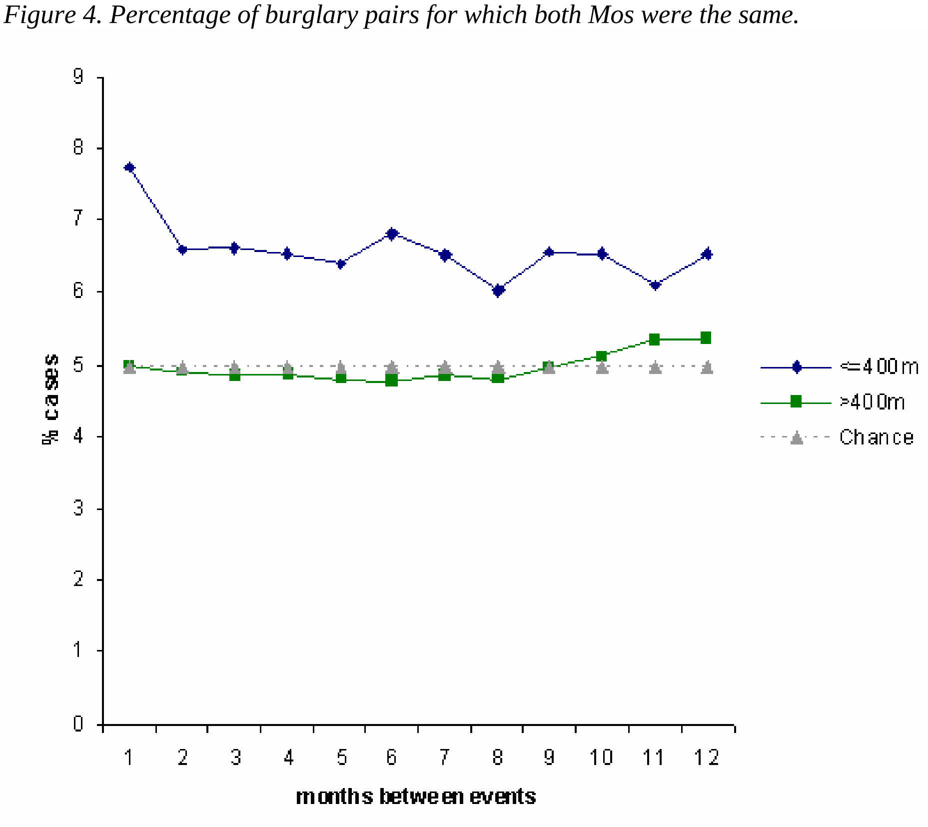
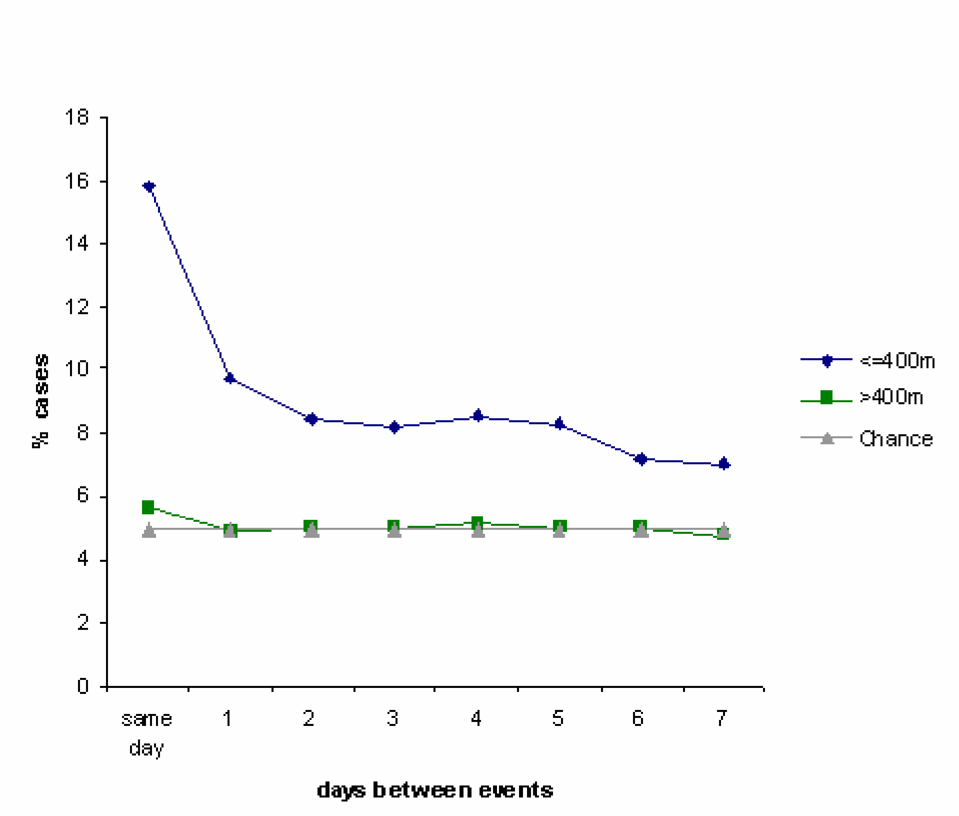


Figure 5. Percentage of burglary pairs for which both MOs were the same.



similar way than those further apart. Again, the difference achieved statistical significance (z=3.06, p<.005, two-tailed). In contrast to the results above, however, for events that occurred within 400m of each other, the results also indicate a fairly strong space-time interaction. Thus, burglary pairs that occurred within 400 metres of each other were more likely to have the same MOs (POE and MOE) if they occurred less than one month apart. No such effect is discernible for burglary pairs that occurred further than 400 metres apart.

The temporal unit of analyses used here (months) may have masked the full extent of the effect observed. For this reason, we conducted further analyses that considered a smaller period of time: the number of days between burglary events. The results are shown in Figure 5.

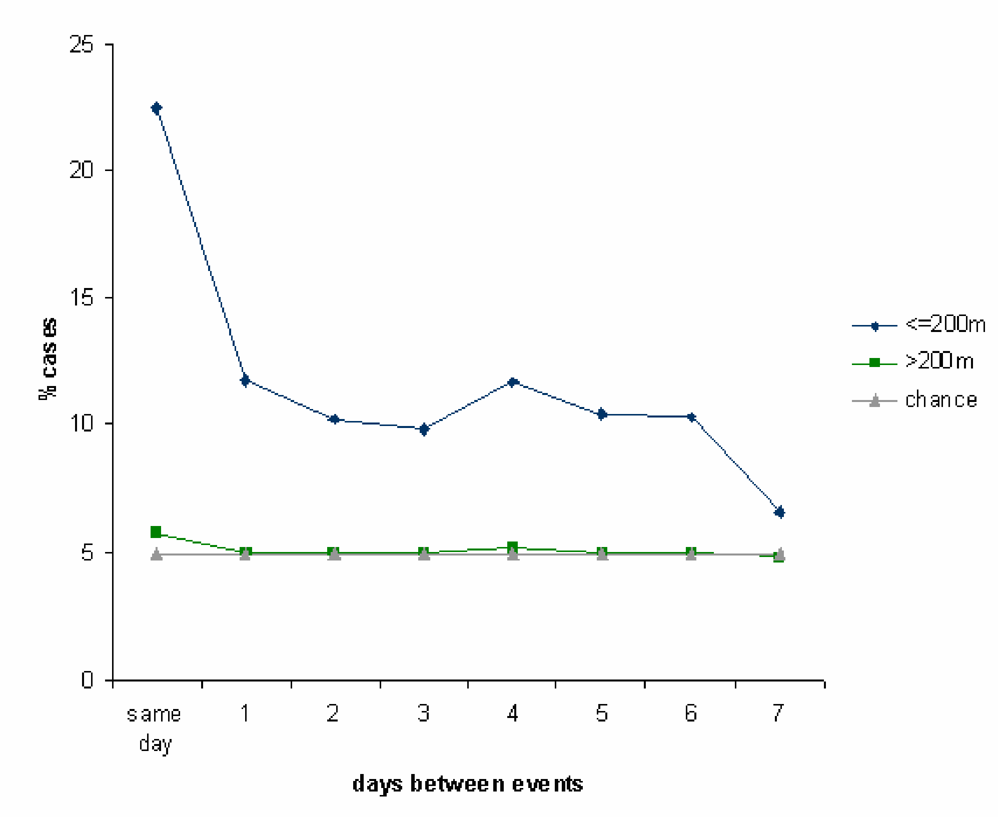
Figure 5 shows that for offences that occurred within 400 metres and one day of each other, the percentage of events for which both MOs were the same (16%) was over three times greater than we would expect on the basis of chance. Considering events that occurred within 400m of each other more generally, there was a much greater tendency for crimes committed within one week of each other (M=9.12%, range 7.01% to 15.80%) to share the same MOs (POE and MOE) than for those that occurred one month or more apart (M=6.48%, range 6.03%-6.63%). Furthermore, the rate with which crimes that occurred within 400m and one week of each other shared the same two MOs was almost twice the equivalent figure for burglaries that occurred over 400m apart (M=5.05, range 4.70-5.66).

To explore this pattern of results further, Figure 6 shows the same analyses for events that occurred within, or further away than, 200m (rather than 400m) of each other. The apparent trend is similar to that shown in Figure 5, but the pattern is clearly amplified. Hence, for burglaries occurring within one day and 200 metres of each other, both the MOE and POE matched in approximately 23 percent of cases (almost five times greater than chance). Again, the time-decay signature was only evident for burglaries that occurred nearest to each other (within 200m).

Are near repeats more likely to have the same MOs?

The above analyses suggest that, relative to burglaries that occur some distance apart (>400m), there is a significant difference in the consistency with which the same MOs are used for events that occur closer together in space. There also is evidence to suggest that there is a space-time interaction, such that events that occur close together in space *and* time, particularly

Figure 6. Percentage of burglary pairs for which both MOs were the same.



within 200m and a few days, are more likely to share the same MOs for both means and point of entry. In relation to the time-space interaction, the above figures have shown visual trends in the data and have given some indication of the probabilities involved in the patterns found. However, it is important to test whether these trends are statistically significant or not.

To do this, we used a series of logistic regression models. Logistic regression models are used to estimate the likelihood that a particular set of results would be observed in a trial, given certain values of one or a series of independent variables. Expressed in a slightly different way, given a certain configuration of one set of variables, what is the probability that we will observe a specific pattern in another? Here the question of interest was whether or not burglaries that occur close together in space and time (near repeats) were more likely to share the same MO than those that occurred further apart (in space and time).

Table 1 shows the result of three different logistic regression models. In each case, the dependent is the likelihood that a pair of crimes would share the same MO. For the first model, 'matches' are defined on means of entry only, in the second on point of entry only, and for the third on both means of entry and point of entry. The independent variables in each case are the distance between crimes, the time between crimes, and the distance-time interaction variable expressed as odds ratios of the independent with the dependent (e.g. $e^{\beta 1(\text{distance})}$ in the equation below). The general form of the logistic regression equation is therefore:

$$\frac{P(\text{MOs match})}{P(\text{MOs don't match})} = e^{\beta 0} \times e^{\beta 1(\text{distance})} \times e^{\beta 2(\text{time})} \times e^{\beta 3(\text{distance x time})}$$

Where the odds ratio is equal to 1, this indicates that there is no relationship between the likelihood that two burglaries will share the same MO(s) and the independent variable of interest. Positive odds ratios of over 1 indicate that there is a greater likelihood that the MO(s) will be the same for two crimes for increasing values of the independent variable. In relation to the coding of the independent variables for the distance between crimes, a value of 1 indicates that two burglaries occurred within 400 metres of each other (zero that they occurred more than 400m apart). For the time between events, a value of 1 indicates that the events occurred less than one month apart (zero more than one month). The associated p-values shown in Table 1 indicate whether or not the odds ratios of the independent variables are statistically significant.

The first model, shown in the first row of the table, indicates that burglaries which occur close together in space (but not necessarily time) are more likely to share

Table 1. Logistic Regression Models for Matching Mos.

	Distance	Time	Distance-Time Interaction
Means of Entry	OR=1.182 p<0.001	OR=1.009, p=0.002	OR=1.069, p<0.001
Point of Entry	OR=1.198, p<0.001	OR=1.001, p=0.745	OR=1.080, p<0.001
Both Mos Match	OR=1.361, p<0.001	OR=1.026, p<0.001	OR=1.173, p<0.001

the same MOE. Equally, it is clear that the MOE is more likely to be consistent for burglaries that occur within one month of each other. The space-time interaction term also was significant, indicating that burglary pairs defined as 'near repeats' (in other words those within 400 metres and occurring less than a month apart) are more likely to share the same MOE than those that are not near repeats. Importantly, this effect is over and above the main effects of space (where victimised houses physically close to each other are more likely to have matching means of entry) and time (where houses victimised within a certain time of each other are more likely to have matching means of entry). Thus, whilst burglaries that occur near to each other in space are more likely to share the same MOE, they are even more likely to share the same MOE if they *also* occur close together in time, although it should be noted that the low value of the odds ratios indicates that the patterns are fairly subtle, albeit statistically significant.

The second model shows the same trends for matching POE. It is interesting to note that for this MO there is no main effect of time. Thus, burglaries that occur within short intervals of each other are no more likely to share the same POE than events for which the elapsed time is longer. This contrasts with the findings for MOE and may suggest that there are temporary 'fashions' in the MOE employed by offenders, but that the generally preferred POE endures. Importantly, however, there is a significant space-time interaction indicating that burglary events that occur close in space *and* time are more likely to share the same POE.

The third model shows the results for the likelihood that both MOs will be the same for any two burglaries. Here, in all cases the odds ratios are larger than in the other two models. This means that there was a stronger association between when and where crimes were committed and how they were committed when both MOs were considered simultaneously. In particular, we see that near repeats are 1.17 times more likely to have both MOs matching than other burglary pairs. This can be compared to likelihood ratios of 1.07 for matching means of entry and 1.08 for matching points of entry. Thus, in line with the patterns revealed in graphs 4-6, the results indicate that crimes that occur close in both space and time are more likely to share the same MOs than those that do not.

DISCUSSION

Earlier work discussed in the introduction demonstrates clearly that the risk of victimisation is communicable. One of the central assumptions made in relation to this finding is that the same offenders, or their associates, are responsible for crimes that form part of a space-time cluster series (near repeats). If this conclusion is valid, then we would expect to see certain patterns in the way that crimes are committed. Given the evident behavioural consistency in the way in which offenders commit crimes, if near repeats are committed by the same offenders we would expect them to be committed in a more similar way to their antecedents than other crimes. In the current paper, we tested this hypothesis by comparing the consistency with which crimes committed close together in time and space (near repeats) were conducted with other pairs of burglaries. A number of findings emerged.

For the means of entry used to gain access to properties, the rate with which the same MO was used for crimes that were committed over 400m away from each other did not differ from what would be expected on the basis of chance. In contrast, for crimes committed within 400m of each other, the rate was significantly greater than would be expected. For crimes committed nearby to each other, there was subtle evidence of more consistency for burglaries that were *also* committed shortly after each other. Similar results were observed for the point of entry used.

A much clearer pattern of results was apparent for the analyses that considered the rate with which *both* MOs were consistent between events. Again, for crimes that occurred over 400m from each other, the rate with which the same MO (POE and MOE) was used did not differ from what would be expected on the basis of chance. However, for crimes committed within 400m of each other, the rate was much higher. There was also clear evidence of a space-time interaction. Crimes that occurred within 400m and one month of each other were almost twice as likely to share the same MO as those that occurred within the same period of time but further away from each other. And, importantly, crimes that occurred within 400m of each other were more likely to share the same MO where less time elapsed between events. This pattern was particularly evident in the analyses for which smaller units of time were considered. Thus, crimes that occurred within one day and 400m of each other were over three times as likely to share the same MO as those that occurred over 400m from each other.

Thus, the analyses suggest that crimes committed near to each other both in space *and* time are more likely to be conducted in the same way than other crimes. Critically, this pattern was observed after the separate influences of the distance between events and the time between events had been taken into account, thereby demonstrating that it was not simply an extension of these more general patterns. To elaborate, consider that if events were purely independent of each other - carried out by completely different offenders that just happened to choose the same MO - then, as a consequence of the likely similarity in access opportunities of nearby homes, we might anticipate a similarity in the way that crimes committed near to each other were conducted. However, there would be no reason to suspect that this similarity would vary depending on the time that elapsed between events[3]. Thus, the results represent an event-related signature.

Therefore, the results appear consistent with the hypothesis that there is dependency between events that occur close together in both space and time. Consequently, the next question to answer is in what way are near repeats dependent on each other? A number of alternatives exist, as follows:

1. The same offender has committed the burglaries.
2. A group of co-offenders offend in an area together.
3. A more general 'offender network' has discovered that good opportunities exist within a certain area and brief each other about the opportunities and successful MOs.
4. There is a new vulnerability in an area (e.g. a CCTV camera or security gate is removed) that is manipulated by unrelated offenders within a short space of time.
5. Offenders are displaced or deflected from other nearby areas as a result of a crime prevention intervention and subsequently move into the same area simultaneously.

The last of these alternatives is the least plausible. If offenders were displaced from one area to another, this would clearly impact on the rate of the crime in the area. There is no reason to believe that such a change would have a systematic impact on the *way* in which crimes were committed in the area, in the way considered here. The fourth explanation is also fairly unlikely to generate the results observed. For instance, if the conditions in an area changed in a way that had implications for the way in which offenders commit offences, this would need to be a temporary change or otherwise offenders would continue to use the same MO over longer periods of time. If there were frequent changes within an area this could cause the results observed, but such changes are unlikely. Consequently, perhaps the most likely explanation is that an offender or group of offenders favor a particular MO and use this where appropriate. In support of this, Everson and Pease (2001) report that for a sample of offenders in West Yorkshire, crimes committed on the same street were typically committed by the same offender(s).

In this paper we have used offence data only to examine the relationship between offences. If information on case status and detections was made available, future research could examine the extent to which those offences which are defined as being strongly associated by the methods reported here are, in fact, actually carried out by a common offender or group of offenders. This would be a good method of further testing the state dependency hypothesis.[4]

The above findings and their interpretation have a number of implications for crime prevention and detection, some of which will now be discussed. In a recent paper (Bowers, Johnson and Pease, 2004), we have discussed how the finding that the risk of crime is communicable can be used to predict the location of future crimes. Using this method a geographical map can be generated to indicate future areas of high risk. We have called this method prospective mapping to distinguish it from retrospective techniques such as traditional hotspot mapping. In a comparison of the predictive efficiency of the different techniques, we have shown that prospective mapping is significantly more accurate than extant methods, correctly identifying the future locations of between 64%-80% of burglary events for the period considered (Bowers et al. 2004, Johnson et al. 2004). The current findings suggest that an extension to the general method may be warranted. As well as predicting when and where crimes will be committed, the findings suggest that it should also be possible to anticipate *how* they might be committed. The implication of this is that crime reductive resources may not only be directed to the right places at the right times, but the most appropriate tactical options may be selected. For instance, in an area where a series of near repeats occur and the favored MO is to gain access via a rear window using a brick, installing better locks on front doors would be unlikely to have a crime reductive effect.

In relation to crime detection, monitoring the constellations of spatial and temporal patterns of crime could assist with the detection of offenders. If, as the data suggest, it can be assumed that offenders are likely to visit houses near burgled homes within short spaces of time, covert surveillance schemes could be used in areas where near repeats events are particularly prevalent. Alternatively, silent burglar alarms monitored by the police could be given to burglary victims and their neighbors for a short period of time following an initial event. This strategy has been used effectively in the past to reduce repeat burglary (Anderson et al. 1995), and hence this suggestion represents an extension of a tried and tested intervention.

To optimize the effectiveness of such strategies, it may be sensible to adopt these techniques in areas where there is not only evidence of repeat victimization or near repeats, but also where the consistency in the MO used to gain access to burgled homes exceeds a certain threshold[5], as this may suggest the increased likelihood of a common offender. Research concerned with repeat victimisation (Everson and Pease 2001) suggests that those who commit repeat victimisation tend to be prolific offenders well established in their criminal careers. If the same is true for those that commit near repeats then these types of strategies offer the opportunity to catch offenders quickly and to apprehend those responsible for the bulk of offences[6].

Perhaps a more effective way of linking crimes would be to use physical evidence such as DNA recovered from domestic burglary crime scenes. In England and Wales, although scene of crime officers attend around 70 percent of domestic burglary crime scenes, DNA is only recovered at around 5 percent of locations, fingerprints at around 27 percent (Williams 2004). This would clearly limit the utility of such an approach but it would enable some analyses to be conducted, particularly in police forces where the recovery rates are highest.

To recapitulate, the results of the current analyses show that near repeats are committed with greater consistency than other crimes. To the authors, this suggests a common offender across near repeat event series. Data from interviews with offenders also suggest that this conclusion is, to some extent, warranted (Ashton et al. 1998). In any event, the results have clear implications for operational policing, both in relation to crime prevention and detection. Future research may determine whether or not the consistency with which crimes are committed co-varies with other factors. An examination of the time of day would be particularly useful given the implications the findings could have for the precise timing of crime reductive effort (see, for example, Ratcliffe 2002). Equal consideration could be also given to the area in which crimes are committed, the type of housing in the area, and the goods stolen.

ENDNOTES

1. The authors would like to thank Ken Pease for comments on an earlier draft of this paper. Thanks also go to Barry Webb for discussions regarding the potential use of DNA in crime linking.

2. However, as pointed out by one of the reviewers, information concerning the relationship between the victim and offender may help to explain how the offender gained knowledge of the opportunity. This would be an interesting issue to pursue in further research.

3. Unless, of course, there were systematic changes in the area at specific points in time that made some MOs favourable for a period of time and others at another.

4. Thanks go to one of the reviewers for suggesting this.

5. The authors would like to thank Gisela Bichler for pointing out this possibility. Various standard statistical techniques could be used to operationalise this approach.

6. For instance, it has been estimated that between 5 percent and 19 percent of the population accounts for over one-half of all crime (e.g. Wolfgang, 1983).

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