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Consistency and specificity in burglars who commit prolific residential burglary: Testing the core assumptions underpinning behavioural crime linkage

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Purpose. Behavioural crime linkage is underpinned by two assumptions: (a) that offenders exhibit some degree of *consistency* in the way they commit offences (their *modus operandi* [MO]); and, (b) that offenders can be differentiated on the basis of their offence behaviour. The majority of existing studies sample at most three crimes from an offender's series of detected crimes and do not examine whether patterns differ across offenders. Here, we examine patterns observed across the entire detected series of each sampled offender, and assess how homogeneous patterns are across offenders.

Methods. Using a non-parametric resampling approach, we analyse the entire crime series of 153 prolific burglars to determine if they exhibit consistency and specificity in the way they commit offences.

Results. Findings suggest that offenders exhibit consistency in the way they commit offences. With respect to specificity, our results suggest that patterns are not homogeneous across offenders or the type of MO considered – some offenders exhibit more specificity than do others, and offenders are more distinctive for some aspects of their MO (particularly spatial choices) than they are for others.

Conclusions. The findings provide support for the underlying principles of crime linkage, but suggest that some aspects of an offender's MO either conform to a common preference, or are perhaps more influenced by situational factors than stable scripted preferences. That some offenders fail to demonstrate sufficient specificity for accurate linkage suggests that identifying which crimes are likely to be the work of offenders who display more specificity *a priori* constitutes one challenge for future research of this kind.

Research consistently indicates that a small proportion of offenders are responsible for a majority of crimes (Farrington, 2003; Wolfgang, Figlio, & Sellin, 1972). As such, substantial resources are devoted to policing prolific offenders (Innes, Fielding, & Cope, 2005). Behavioural crime linkage (hereafter, crime linkage) – an analytical technique concerned

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with the identification of a series of offences committed by a single perpetrator out a pool of unsolved crimes (Grubin, Kelly, & Ayis, 1997; Woodhams, Hollin, & Bull, 2007) – can play a significant role in the detection of prolific offenders.

Ideally, crime linkage could always be achieved using physical or other identifying evidence (e.g., fingerprints, DNA, witness statements), but such evidence is often unavailable (Davies, 1991). As a result, crime linkage is carried out using other categories of crime scene evidence, such as the offender's *modus operandi* (MO), loosely defined as the constellation of the observable traces of the actions performed by the perpetrator during the commission of the offence. Data relative to MO are analysed to uncover patterns of similarity and differentiation between crimes of the same type, such as burglary or theft from a motor vehicle (Canter, 2000). If successful, crime linkage allows for the centralization and rational allocation of investigative resources (Godwin, 2001), facilitating the detection of prolific offenders. The aim of crime linkage research is, ultimately, to develop decision-making support systems for use by crime analysts and investigators (Bennell, Snook, Macdonald, House, & Taylor, 2012; Woodhams & Toye, 2007).

Underpinning crime linkage are two explicit hypotheses (Woodhams *et al.*, 2007). The first, the *consistency hypothesis*, states that offenders will behave somewhat consistently across a series of offences of a similar type. The second, the *specificity hypothesis*, states that offenders can be differentiated on the basis of their offence behaviour. For crime linkage to be possible, *some* degree of similarity must be observed between the MOs displayed by the same offender at multiple crime scenes, and *some* degree of difference must be observed between the MOs displayed by different offenders across crime scenes (Canter, 1995).

While there has been much work on crime linkage, arguably, the explicit testing of these hypotheses has not received the attention it deserves using appropriate statistical methods (see also, Salo *et al.*, 2013). In this article, we set out to test directly the consistency and specificity hypotheses using data for a sample of burglars who committed prolific residential burglary in the United Kingdom. First, we discuss why we might expect behavioural consistency and specificity (or lack thereof) in the crimes of prolific burglars, and then review previous crime linkage research, focusing in particular on that concerned with residential burglary. We then discuss a metric for measuring consistency and a method for establishing its statistical significance not used hitherto. After presenting a set of analyses for our sample of burglars who committed residential burglary, we conclude with a discussion of the implications of our findings for future crime linkage research on residential burglary.

Sources of consistency and specificity in burglars who commit residential burglary

Studies of convicted burglars have revealed clear targeting and offence commission strategies (Cromwell, Olson, & Avary, 1991; Hearnden & Magill, 2004; Palmer, Holmes, & Hollin, 2002; Rengert & Wasilchick, 1989; Wright & Decker, 1994), which leads to the expectation that burglars will display some notable degree of consistency in their MO. The evidence regarding possible sources of specificity is more ambiguous. To the extent that a majority of burglars who commit residential burglary use the same criteria to evaluate and search for targets (Wright & Decker, 1994), their behavioural consistency would lack specificity; that is, burglars could not be differentiated on the basis of MO, since they would all go after similar targets in the same way. The fact that burglary skills are transmitted among offenders (Bennett & Wright, 1984; Maguire, 1982; Rengert &

Wasilchick, 1985) could be another factor of uniformity, and therefore low specificity. However, studies have also indicated that offenders differ on the basis of their sensitivity to situational characteristics and the amount of risk they are willing to take, as a factor of age and related level of expertise (Coupe & Blake, 2006; Nee & Meenaghan, 2006) or relative to their degree of sophistication (Jacobson, Maitland, & Hough, 2003; Rengert and Wasilchick, 1985). Burglars have also been shown to differ in their ability to articulate the perceptions and reasoning behind their decision-making process, some appearing more deliberate than others in their assessment of environmental cues and their cost–benefit analysis (Bennett & Wright, 1984; Tunnell, 1992; Wright & Decker, 1994). Such differentiation in burglars' thinking styles and decision-making abilities could be another source of inter-individual variation in their mode of operation.

Importantly for crime linkage, a number of factors could lead to the alteration of MOs over time, both across the population of burglars and within individual offenders. New MOs emerge as new tools are made available, knowledge propagates, or new opportunity-blocking measures are encountered (Ekblom & Tilley, 2000). Prolific burglars are likely to rely on cognitive scripts that have proven successful in the past (Nee & Meenaghan, 2006; Wright & Decker, 1994), but they are also subject to learning processes (Douglas & Munn, 1992; Turvey, 2002; Wright, Logie, & Decker, 1995), notably in the early stages of their career. Criminal career research indicates that offender versatility is the rule rather than the exception (Farrington, 1994; Gottfredson & Hirschi, 1990; but see, Johnson, Summers, & Pease, 2009), suggesting that learning processes relevant to MO could occur intra-individually across crime types, though this does not rule out short-term specialization in MO within crime type (Hochstetler, 2002). It has also been proposed that criminals' MOs can evolve or 'de-evolve' over time, as a result of increased confidence or deteriorating mental states brought on by drug use (Turvey, 2002).

In short, while there are grounds to expect that burglars can be differentiated on the basis of traditional MO behaviours, it is also possible that a large measure of similarity prevails across individuals, to the extent that several features have been commonly associated with a target's vulnerability to burglary (Budd, 2001; Hakim, Rengert, & Shachmurove, 2001), and that these features could, in turn, characterize a non-trivial number of offences. If this were the case, then while offenders may be consistent with respect to their own MO, that MO may simply reflect a profile that is common across offenders, thereby offering little potential for crime linkage.

Testing consistency in serial offenders

Hypothesis testing requires the use of specific methodological procedures and statistical tests. Different approaches may provide different insights. In the past, researchers working on crime linkage have obtained data for a sample of offenders who committed two or more detected crimes and included in their analysis a maximum of three crimes per offender (e.g., Bennell & Canter, 2002; Bennell & Jones, 2005; Bennell, Jones, & Melnyk, 2009; Davies, Tonkin, Bull, & Bond, 2012; Markson, Woodhams, & Bond, 2010; Santtila, Junkkila, & Sandnabba, 2005; Tonkin *et al.*, 2012; Woodhams & Toye, 2007; see, however, Harbers, Deslauriers-Varin, Beauregard, & van der Kemp, 2012; Salo *et al.*, 2013; Woodhams, Hollin, & Bull, 2008), either to estimate the degree of consistency and specificity exhibited by the offenders, or to classify events as belonging to one series or another. The rationale behind the sampling strategy adopted is that randomly sampling two offences (occasionally three) for each offender should ensure that the findings cannot be distorted by prolific criminals, who may display greater or lesser behavioural

consistency, as well as allowing more offenders to be considered 'serial' (having committed two or more offences), thus enabling researchers to include a larger number of offenders – though not necessarily offences – in the sample (Bennell & Canter, 2002; see Woodhams & Labuschagne, 2011, for a discussion of issues with this approach).

Such tests focus on how consistent a group of offenders are in the aggregate for a particular type of MO, but not on how consistent individual offenders are across a series of offences. Where tests such as logistic regression are used to test hypotheses, one assumption is that patterns will be relatively homogeneous across offenders (i.e., fixed, rather than random, coefficients are estimated), such that a sufficiently large number of offenders will be consistent and equally distinctive for particular behaviours. This is not the same as examining whether offenders display any evidence of consistency or specificity for any aspect of their MO, which is the aim of this study.

In the article, we use a different approach and estimate how consistent prolific offenders are across the *entire series* of their detected offences, and how typical it is to observe consistency for particular behaviours in our sample. These are different questions from those that have been addressed in the crime linkage literature to date. These questions test the consistency and specificity hypotheses more directly than has been the case in much of the previous research.

For what behaviours do we anticipate consistency?

Having established how what we aim to achieve differs from prior research, we now consider additional hypotheses. Ecological theories of crime (Brantingham & Brantingham, 1993; Cohen & Felson, 1979) explain how criminal opportunities emerge at the intersection of an offender's routine activity space and of the environmental backcloth. The organization of the backcloth determines the location of the offender's activity nodes and the routes between them, which in turn shapes their awareness of the criminal opportunities afforded by the environment. In line with this, research consistently indicates that offenders commit crimes predominantly within this awareness space (e.g., Rengert & Wasilchick, 1985; Wiles & Costello, 2000), and hence whatever the methodology adopted, offenders would be expected to display consistency with respect to *where* they commit offences. Insofar as offenders will live at different locations and have different routine activity nodes, they should also display some degree of distinctiveness for where they offend.

In line with this, in the existing crime linkage literature and using the methods described above, spatial (inter-crime distance) measures of behavioural similarity have been found to be particularly good at distinguishing between pairs of linked or unlinked offences, within and across crime types, and such findings have been replicated across different study areas, which suggests the external validity of this finding (Bennell & Canter, 2002; Bennell & Jones, 2005; Goodwill & Alison, 2006; Markson *et al.*, 2010; Tonkin, Santtila, & Bull, 2011; Tonkin, Woodhams, Bull, Bond, & Palmer, 2011). In contrast, what might be termed MO behaviours (e.g., target selection, mode of entry, property stolen in cases of burglary, acts committed in cases of sexual assault) have been found to perform less well as linkage variables (with some exceptions; see, notably, Woodhams & Toye, 2007; Tonkin *et al.*, 2012), especially when considered independently of other characteristics. However, when interpreting such results with respect to the core assumption of crime linkage, it is important to remember how the indices of consistency typically used are derived and the limitations associated with this approach.

Returning to theoretical issues, we should note that any categorization of a burglar's offence behaviour into 'domains' (e.g., traditional MO vs. geospatial domains) is somewhat artificial, inasmuch as domains cannot be conceptualized as strictly independent from each other. Furthermore, studies of decision-making stress the role of environmental cues in determining burglars' targeting and search strategies (Nee & Taylor, 1988). From an ecological perspective, motivation to offend is a situational mechanism (Wikström, 2006). For prolific burglars, search and targeting decisions can seem automatic to the point of unintentionality, in that a stable set of cues is perceived and elicits scripted responses or 'obligatory processes' (Nee & Meenaghan, 2006). In addition, prior offending leads to awareness of opportunities for future burglaries (Bennett & Wright, 1984). In the light of all this, we may expect some degree of codetermination, or – if the term is too strong – of mutual constraint between physical environment, geospatial behaviour, planning, target selection, and extant MO behaviours (e.g., the type of target may constrain the method of entry). Put differently, backcloth configuration could limit the potential for variability in MO behaviours, and this 'ecological constraint', if it affects any one MO behaviour, might constrain others by logical association.

As discussed above, the two core assumptions that must be met for crime linkage to be successful are that offenders must display consistency in the way that they commit their crimes, and that they are distinctive (specific) in the way that they commit their offences, such that all offenders are not consistent in exactly the same way. We suggest that to test these core assumptions directly, and to allow a better test of the underlying theory, it is necessary to examine patterns observed across prolific offenders' entire series of detected crimes, rather than pairs of their offences, as is the case in a majority of crime linkage studies.

In the existing literature, patterns of consistency are typically examined in the aggregate and in such studies, estimated coefficients are fixed for the entire sample.[1] In this way, it is essentially (arithmetically if not theoretically) assumed that the degree of consistency observed will be relatively homogeneous across the sample. However, this is not necessarily the case and some offenders may be more consistent than are others. In line with this, Townsley and Sidebottom (2010) show that while most residential burglaries are committed close to an offender's residence, offenders vary quite considerably (see also, e.g., Markson *et al.*, 2010) in the extent to which their journey to crime conforms to a pattern of distance decay – a finding that illustrates how patterns observed in the aggregate may not apply at the level of the individual – the problem of the ecological fallacy. Thus, to estimate the extent to which consistency and specificity exist across offenders, or for particular aspects of an offender's MO, we use a more disaggregated form of analysis than has typically been employed hitherto, and test the following hypotheses:

Hypothesis 1: Offenders will display consistency in the way (area of offence, type of home targeted, method and point of entry, time of day, occupancy of home) they commit offences across a series of crimes – the consistency hypothesis.

Although findings from previous linkage studies lead us to expect that offenders are more likely to display consistency with regard to temporal and geospatial behaviour (time

[1] *In some studies (e.g., Markson et al., 2010), indices of consistency such as a Jaccard's coefficient are computed for individual offenders. However, in such studies only two offences from an offender's entire series of detected offences are usually sampled, and statistical tests are still conducted at the aggregate level.*

of day, area of offence), rather than more 'behavioural' MOs (type of target, method and point of entry, occupancy), we restate the consistency hypothesis in full, as we believe it is worth putting wholly to the test in the light of the new methodological approach adopted here. This said, we do expect that some categories of MOs (notably, geospatial) will display greater consistency than others.

Hypothesis 2: Patterns of consistency for particular MO characteristics will differ between individuals, and individuals will exhibit preferences that differ from the aggregate patterns observed across all offenders – the specificity hypothesis.

Hypothesis 3: Offenders who are more consistent in where they commit their offences will also be more consistent in other types of MOs, which are plausibly constrained by the choice of offence area (e.g., type of home targeted; mode of entry) – the ecological constraint hypothesis. In turn, some types of MOs may also constrain each other (e.g., type of target and mode of entry).

Method

Data

The sample for this study was drawn from all residential burglaries detected by the police in the county of Dorset (UK), between January 2001 and December 2005. In the United Kingdom, in line with Home Office counting rules (Home Office, 2011), detected crimes are those for which there is sufficient evidence to charge an offender. Offences analysed here were a mixture of those detected through investigative effort and those that were *Taken into Consideration* (TIC). Offences TIC are those for which, at the point of arrest (or shortly afterwards) an offender asks for them to be TIC. To be counted as a TIC, other verifiable information (e.g., forensic evidence) must exist that links the offender to the crime(s) concerned (Home Office, 2011). Such offences will be recorded as being detected, but the offender will not be charged with them. This is of benefit to the offender, as any offences which may have been identified through other means (such as forensic evidence) will not incur them a further sentence (e.g., ACPO & CPS, 2007). For the current sample, the clear-up rate was 13%.

As we were interested in the consistency of prolific offenders, data were only analysed if an offender had been responsible for five or more offences. As is typical for this kind of study, incidents that involved (known) co-offending were excluded from the analysis. Consequently, data were available for a total of 2,050 offences, committed by 153 unique offenders. Offenders committed a mean of 13.4 residential burglaries (SD = 12.5, min = 5, max = 87).

The data included the following fields of information: A unique crime reference number, an anonymized identifier for each offender, the earliest and latest date and time of the offence, the offender's address, the address and geo-coordinates of the burgled venue, the type of home victimized, the method of entry used, the point of entry exploited, and whether the victim(s) were home at the time of the offence. The last four variables were recorded by the police in a fixed format and hence represent categorical variables. The categories associated with each variable are shown in Appendix S1. For the purposes of what follows, it was necessary to discretize the other variables so that observations could be allocated to distinct mutually exclusive categories. For the time of day, we coded incidents to one of two categories: Night (6 pm–6 am) or day (6 am–6 pm). Where the interval of time between the earliest and latest time that an incident could have occurred was equal to or exceeded 24 hr, that incident was coded as 'missing' and excluded from

Table 1. Summary of the indices of consistency (numbers in parentheses indicate how many offenders had five or more offences for which data were available for that modus operandi)

	Index of consistency				
	Categories	Mean	*SD*	Mean/Expected	% of sample significant
Area (153)	79	.28	.25	8.80*	78
Home (145)	7	.37	.23	1.71*	37
MOE (136)	11	.49	.25	1.42*	28
Night/Day (139)	2	.70	.28	1.32*	27
Occupancy (148)	2	.72	.25	1.28*	22
POE (146)	5	.53	.24	1.26*	25

Note. *$p < .0001$.

analyses concerned with the time of day.[2] Where the interval of uncertainty was <24 hr (86% of burglaries), the incident was allocated to the period (night or day) in which it most likely occurred.

With respect to spatial units, to enable the computation of an index of consistency that was comparable to those for the other MOs considered, it was necessary to allocate burglaries to discrete spatial zones. Spatial zones are commonly used in the spatial econometrics literature to examine the preferences of choosers who must make a selection from a set of alternatives. For example, Bernasco and Nieuwbeerta (2005) use a discrete spatial approach to examine patterns of burglar preferences, while others have employed it to examine the spatial decision-making of rioters (Baudains, Braithwaite, and Johnson, 2013), street robbers (e.g., Bernasco & Block, 2009), and commercial robbers (e.g., Bernasco and Kooistra, 2010). The use of discrete spatial zones is thus not only meaningful for comparing the results for the different variables considered, but is consistent with cutting-edge studies of offender spatial decision-making.

A variety of boundaries could have been used. Here, we allocated offences to one of the 77 Local Authority Wards in which burglaries occurred in the county. These areas are a little smaller than those used in most studies that employ a discrete spatial choice approach, containing around 2000 households (compared to around 2,500 in the other studies). We felt that these smaller zones were meaningful, as conceptually they might be thought of as representing a typical person's geographical activity space. While the choice of units will affect analytic outcomes, the approach to hypothesis testing adopted directly controls for this (see below).

As is typical for data of this kind, as illustrated in Appendix S1 and Table 1, some aspects of the MO (e.g., the type of home targeted, whether the home was occupied at the time of the offence) were more consistently available than were others (e.g., the method of entry). In what follows, we only include an offender in an analysis if that offender had five or more offences for which data were available for the MO considered.

[2] *The precise timing of incidents of burglary is often unknown, as the home may be unoccupied at the time of an offence. However, the exclusion of any events for which the victim's uncertainty about the time of the crime exceeded 24 hr, and the use of 12- rather than 1-hr time windows minimizes the problems associated with this issue. Moreover, we selected the two intervals used (night and day) for analysis as they are likely to meaningfully relate to most people's routine activity patterns, and hence the periods within which they are likely to be able to reasonably identify a burglary as occurring within.*

Analytic strategy and results

Are offenders consistent?

As discussed, previous research on crime linkage has typically sampled pairs of crimes committed by groups of offenders and examined the extent to which those that are and are not linked share common characteristics. Evidence of consistency is said to be demonstrated where the former are more similar than the latter. In this article, rather than sampling pairs of offences, we examine each offender's entire detected crime series and examine how consistent they are across them. To analyse crime series (rather than pairs of events) we use an index of consistency and a non-parametric permutation approach to estimate its statistical significance. As far as we are aware, this approach has not been used in crime linkage hitherto.

Measures of how consistent (or diverse) a population is have been developed across a number of disciplines such as ecology (e.g., Simpson, 1949) and information theory (Shannon, 1948). We favour Simpson's index as it is easy to understand and calculate and has been used in numerous studies in other disciplines (e.g., see Blau, 1977; Hirschfield & Bowers, 1997). The index can be interpreted as the probability that any two crimes randomly selected from an offender's series were committed in the same way. Equation (1) is the index Simpson (1949) used corrected for a small sample size (see also Hunter & Gaston, 1988):

$$\text{Index} = \frac{\sum_{j=1}^{n} c_j \times (c_j - 1)}{C \times (C - 1)} \tag{1}$$

Where, Index is an offender's index of consistency for a particular type of MO
c_j is the count of crimes committed using an MO consistent with category j
n is the number of categories for the MO considered
C is the total number of offences for which there is information about the MO

For each characteristic considered, a value of one so derived would indicate that an offender was entirely consistent for that characteristic; a value of .50 that there was a 50% chance that any two crimes within that offender's series will have been committed in the same way; and, a value of zero that no two crimes were committed in the same way. To illustrate using a worked example, consider an offender that commits 10 offences over three spatial zones, committing three crimes in one spatial zone, two in another and five in a third. For this offender, their *spatial* index of consistency would be as follows:

$$\text{Index}_{\text{spatial}} = \frac{(3 \times 2) + (2 \times 1) + (5 \times 4)}{10 \times 9} = 0.31$$

In this case, according to our estimate of consistency, there is a 31% chance that any two crimes selected from the offender's series at random will have been committed in the same spatial zone. Suppose also that this same offender commits eight of their crimes in unoccupied dwellings and only two while the dwelling was occupied. Their *occupancy* index of consistency would be:

$$\text{Index}_{\text{occupancy}} = \frac{(8 \times 7) + (2 \times 1)}{10 \times 9} = 0.64$$

This corresponds to a 64% chance that any two crimes selected at random from the offender's series will have been committed under the same occupancy conditions.

An index of consistency was computed for every offender for each MO characteristic, but for the purpose of presentation Table 1 shows the mean values and standard deviations computed across all offenders. For example, (on average) for any two crimes committed by the same offender, around three-quarters were committed during the same interval of the day (day or night) and just over one third within the same local authority ward.

The results provide support for hypothesis 1 and suggest that the sample of offenders appear to be more consistent for some characteristics than others. In particular, they appear to be most consistent regarding the timing of their offences, and whether the home was occupied at the time of the offence. They appear to be somewhat consistent for the type of home targeted, and the method and point of entry used. On the basis of this index, however, offenders appear to be less consistent for the area targeted.

Do offenders exhibit specificity?

Comparing the raw index of consistency across characteristics as was done above can be a little misleading. For example, for each characteristic the number of possible categories (see Table 1 for details) varies and this influences the values derived. And, as discussed above, changing the particular categories used (such as the boundaries used to define areal units) may affect outcomes. Moreover, this analysis does not help to determine whether there is any specificity to an offender's MO or whether it merely reflects the way that most offenders commit a burglary. A more helpful approach is to compare the observed index to what would be expected, assuming that all offenders commit offences in the same way.

To do this, it is necessary to derive a null distribution for every offender for each MO characteristic. No such statistical distributions exist, nor do distributions exist to estimate the statistical significance of observed differences between the actual and expected distributions for such an analysis. For this reason, we use a non-parametric permutation test to estimate both. To elaborate, according to the null hypothesis, offenders commit their offences in the same way as each other. That is, each MO used by an offender can be thought of as simply representing a random draw from a distribution that describes the population of selections made for a specific type of MO (by all offenders). As the population of selections made is unavailable, we use the sample of data to approximate this. To generate the null distributions (one for each offender), for each MO of interest (e.g., the area of an offence), for each offender's N offences, using a uniform random number generator, we draw one observation from the set of offences included in the police data (with replacement). Thus, to compute one expected value for the null distribution, an offender who committed 10 crimes is randomly assigned 10 MOs from the available sample of data (for each category of MO). The index of consistency for a particular MO is then recomputed using this 'resampled' data and the value included in the null distribution for that offender for that MO. An advantage of the approach is that it accounts for the fact that different offenders will have committed different numbers of crime, and thus that the expected distribution will vary. A full permutation will be virtually impossible, and so a Monte Carlo (MC) simulation is used to randomly sample 9,999 permutations from all of those possible. This generates a distribution of 9,999 indices of consistency for each offender for each MO considered, computed under the null hypothesis.

Figure 1 shows an example of such an analysis for one offender with 40 detections, for the geographical areas targeted. The density plot shows the expected distribution for that

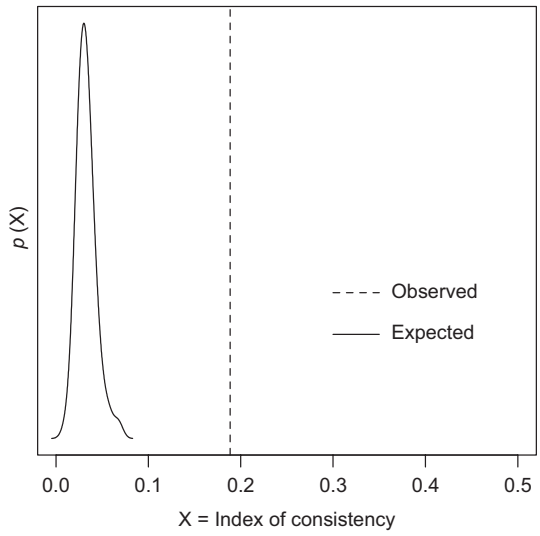

Figure 1. Probability density plot of the expected index of consistency for the geographical areas targeted and that observed for one offender.

offender for that MO, along with the observed value. In the example shown, the (9,999) expected values computed using the MC simulation vary from just above zero to about .07, having a mean expected value of around .03. In contrast, the observed value for the offender considered of .19 was located in the right tail of the expected distribution. This indicates that this offender was (.19/.03=) 6.3 times more consistent than would be expected if their pattern of offending reflected nothing more than the typical profile observed across offenders. This process is repeated for every offender for each MO characteristic considered, enabling us to compare each offender's observed index of consistency for any MO characteristic with the null distribution for that offender for that MO.

Dividing the observed index of consistency by the mean value expected (as above) produces an easily interpretable, standardized coefficient for which values above (below) one indicate that there was more (less) consistency than that expected. To compute the statistical significance of each index of consistency for each offender and each MO characteristic, we use the formula derived by North, Curtis, and Sham (2002):

$$p = \frac{n - \text{rank} + 1}{n + 1} \tag{2}$$

Where n is the number of permutations, and *rank* is the position of the observed index of consistency in a rank ordered (from smallest to largest) list of the values generated using a MC simulation for a particular offender for a specific MO.

In the example shown in Figure 1, the index of homogeneity generated by the MC simulation never exceeded the observed value and so the associated p-value would be $\leq$.0001. By repeating this process for every offender for each MO characteristic we are able to estimate the statistical significance of the consistency displayed by each offender (not just for the entire sample) for each MO considered. In addition to estimating the statistical

significance of the individual indices, we do, however, also estimate the statistical significance of the mean values, computed across all offenders. For each type of MO, we compare the mean index of consistency from the observed crime series with the mean index of consistency obtained from the MC simulation. The statistical significance of the mean index is then computed using equation (2).

The mean value for the index of consistency – computed across all offenders – and the ratio of the mean to expected (according to the null hypothesis) is shown in Table 1. For all types of MO considered, the overall mean for this value exceeded what would be expected. Table 1 is rank ordered by this ratio so that the reader can quickly identify the variables for which the offenders in the sample appear to be most consistent (relative to expectation).

The final column of Table 1 was calculated using the individual indices of consistency for every offender for each MO considered and shows for what percentage of offenders the observed value differed significantly ($p < .0001$) from that expected (for that offender). Considering the measure of effect size and the *p*-values together, offenders appear to be most *specific* for *where* they committed offences, and the *type of home* targeted. In the case of the former, 78% of offenders were significantly more consistent with respect to where they committed their offences than would be expected if their spatial decision-making merely reflected the areas typically targeted by the sample of offenders as a whole. Put differently, for this MO characteristic, most offenders appear to exhibit both consistency and specificity. Compared to expectation, they were relatively less specific for whether there was someone home at the time of the offence, and the point and method of entry used. For example, only 22% of the offenders in the sample displayed more consistency for whether they targeted occupied or unoccupied homes than would be expected, given the general preferences exhibited by all offenders considered. That is, while most offenders exhibited consistency for this aspect of their MO, few exhibited any specificity that would differentiate them from other burglars. This is perhaps unsurprising as burglars are known to target unoccupied homes, and the type of home burgled will be a function of environmental abundance as well as (possibly) reflecting revealed preferences. Perhaps more surprising is the finding that offenders were not particularly specific – with only 27% demonstrating a level of consistency that exceeded chance expectation – in terms of the period of the day they committed their offences. More generally, for every characteristic considered, around two thirds of the offenders exhibited a degree of consistency that did not differ from chance expectation. Put differently, apart from the area in which they offended, many of the offenders exhibited little *specificity* in the way they committed their offences and instead appeared to commit their crimes in much the same way as the others. For such offenders (in this sample at least), their spatial crime patterns provide the strongest opportunity for accurate crime linking.

Are some offenders more consistent than others?

Next, we explore whether there is an association between an offender's consistency for one element of their MO, and all others. This is possible because (unlike most other studies) we computed an individual index of consistency for every offender for each MO characteristic considered. Table 2 shows the pair-wise (Spearman's) correlations for all 15 possible comparisons, computed using the raw indices of consistency. The overall mean correlation – computed across all 15 combinations – of .11 was low, suggesting that offenders vary in the extent to which they are consistent, depending on the aspect of the

Table 2. Spearman's rank order correlations across indices of consistency, and (final column) with crime series length

	Area	Home	MOE	POE	Occupancy	Night/Day	Series length
Area	1.00	.07	.02	.11	−.06	.01	−.24*
Home		1.00	−.01	.28*	.27*	.18*	.17†
MOE			1.00	.18	−.04	.08	.23*
POE				1.00	.18*	.04	−.04
Occupancy					1.00	.29*	.05
Night						1.00	.09

Note. POE, Point of Entry; MOE, Method of Entry; Home, type of home. *$p < .05$; †$p < .10$.

MO considered.[3] Considering consistency in spatial decision-making, it would appear that those offenders who target one or only a few areas are no more consistent in the way they commit their offences than are those that display relatively little consistency in where they commit burglaries. One interpretation of this finding is that any consistency observed is not simply a function of individual offenders targeting particular areas, which could (to some extent) constrain the ways in which they are able to commit their offences. While the correlations were relatively weak, it would appear to be the case that offenders who were more consistent for the type of house they targeted were also more consistent with respect to whether that home was occupied at the time of the offence, the period of the day that they committed burglaries, and the point of entry used to enter burgled homes.

While the association between the likelihood of a home being occupied and the time of day an offence is committed is not particularly interesting (i.e., homes will tend to be occupied overnight more than they are during the day), the type of home targeted will at least in principle be independent of when a home is targeted and whether it is occupied.

Although no specific hypothesis was formulated in relation to this analysis, a final issue examined was whether there was an association between offender consistency and crime series length, as this might provide further context to our other findings. As shown in Table 2, there was no association between crime series length and offender consistency for the time of day offences were committed, the point of entry used, or whether a home was occupied during an offence. For the type of home targeted there was a small non-significant positive trend, and for the method of entry used and the area targeted, there were small but statistically significant associations with crime series length. In the case of the former, offenders who had been detected for more offences tended to be more consistent, whereas for the latter the reverse was true. Overall, series length did not seem to be meaningfully associated with consistency.

Discussion

Most of the research concerned with offender consistency has focused on the utility of using details of an offender's MO to link pairs of crimes together – usually one pair of crimes for each offender sampled. Relatively little research has directly examined the extent to which prolific offenders are consistent across an entire series of detected offences using statistical methods, including tests that estimate the significance of

[3] *Visual inspection of scatterplots indicated that there were no interesting non-linear trends that the correlations might mask.*

obtained values, which is necessary for hypothesis testing. Consequently, previous research has not examined how typical it is for offenders to be consistent for a particular MO, and whether any consistency exhibited is distinct to them. The aim of this study was to examine these issues for a sample of burglars who committed residential burglary and consequently test theories of offender behaviour and decision-making.

Our findings suggest that when we examine each aspect of an offender's MO without reference to general patterns of offending, offenders appear to display consistency in the way in which they offend (Hypothesis 1), though they do so for some attributes more than others, an outcome in line with previous research in burglary linkage (e.g., Bennell & Canter, 2002; Bennell & Jones, 2005; Markson *et al.*, 2010; Tonkin, Santtila *et al.*, 2011; Tonkin, Woodhams *et al.*, 2011). However, when we compare the extent to which they are consistent with what would be expected, assuming that all offenders commit offences in much the same way, it appears that offenders are more specific for different aspects of their MO, than we might otherwise have concluded. They exhibited the most specificity for the geographical area targeted, with more offenders (78%) demonstrating specificity for this aspect of their MO than any other. Although fewer offenders (37%) exhibited specificity for the type of home targeted, on average they demonstrated nearly twice as much consistency for this aspect of their MO than would be expected. These findings are important from a theoretical perspective, providing support for the theories of offender decision-making discussed in the introduction, and hence for the underlying principles of crime linkage.

However, it is also notable that in the case of spatial decision-making, offenders who had committed more offences appear to be less consistent – across their entire detected crime series – in terms of where they committed offences, than were those who committed fewer. Such a finding suggests that while geospatial information may be the most useful aspect of an offender's MO for crime linkage, there may eventually be diminishing returns, an aspect which the empirical literature has not investigated explicitly up to this point. This finding is not incompatible with the theories discussed in the introduction and may in fact be explained by contemporary theories of offender spatial decision-making. For example, Johnson and colleagues (e.g., Johnson & Bowers, 2004; Johnson *et al.*, 2009; Summers, Johnson, & Rengert, 2010) discuss offender foraging strategies and provide evidence, both quantitative and qualitative, to suggest that prolific offenders often commit offences in one area over a period of days but then quickly relocate their activity in the fear that it would otherwise attract police attention and increase their likelihood of apprehension. Such a strategy could easily lead to a more dispersed geographical pattern of activity than would be expected for less active offenders who would not be so concerned that their activity would attract police attention in a particular geographical area. Further research would be necessary to test this hypothesis more directly, and to establish more precisely which categories of behaviours may gain or lose in consistency as series length increases, since different mechanisms are likely to be implicated in different aspects of offence behaviour (e.g., learning processes; see Sorochinski & Salfati, 2010, for a discussion in the context of serial homicide; or ecological constraint; see the discussion below).

Our findings also show that for some aspects of their MO (e.g., the point of entry used, whether a home was occupied), a large proportion of the sample (around 75%) exhibited insufficient specificity in their pattern of offending for them to be differentiated from their counterparts on that aspect of their MO (Hypothesis 2). On this basis, these aspects of their MO would – at least in isolation – seem to offer less insight for crime linkage analysis, particularly across an offender's series of offences. This suggests that some aspects of an

offender's MO either conform to a common preference, or are perhaps more influenced by situational factors than by stable scripted preferences.

With respect to this latter point, it is notable that the two aspects of their MO that offenders exhibited the most specificity for were, perhaps contrary to expectations, aspects which are arguably less ecologically constrained (Hypothesis 3). That is, while offenders can select an area in which to offend and (to a lesser extent perhaps) particular types of homes to target, their choice of point and method of entry will in part be determined by the presenting opportunities in the geographical area selected. Likewise, assuming that offenders wish to avoid homes that are occupied at the time of the offence, this aspect of their MO will in large part be determined by the area in which they decide to offend, as it is the routine activities of the residents that determine when homes are occupied and when they are not. The issue of ecological and mutual MO-constraints is perhaps one that deserves more systematic attention than it has been afforded up to now, and one which might, in particular, benefit from cross-contextual, comparative research designs looking at entire detected crime series.

As with any research there are, of course, limitations to the findings reported. First, not all crime is detected by the police and hence our findings are based on only a sample of those committed and solved, and this may not be representative. Second, the offences analysed included TICs and it is possible that some of these offences were not actually committed by the offenders to whom they were attributed. While we cannot rule this out, this seems unlikely for the following reasons.[4] As discussed, Home Office counting rules require that adequate evidence (see above) is available to corroborate any offences that offenders nominate as TICs. Furthermore, interviews with burglars in the study area suggest that they nominate offences to be TIC only if they have committed them and believe that the police are likely to detect evidence that could be used to prosecute them (for details of the study, see Summers *et al.*, 2010). These issues are, of course, true of all research that uses crimes detected by the police.

Third, for obvious reasons, we analysed only those crimes that were cleared to prolific offenders, and it may be that those who are less active exhibit more consistency than do those considered here. Second, crimes that were known to involve more than one offender were not examined and it is possible that patterns for co-offending differ from those reported here. Fourth, the study focuses on a single crime type, in a defined geographical area, and hence we cannot make claims as to the relevance of the findings for other crime types in other contexts (see Tonkin, Santtila *et al.*, 2011; Tonkin, Woodhams *et al.*, 2011; for a cross-national study of crime linkage, showing varying results in each country), though the study does introduce new questions of relevance for crime linkage, which are not conceptually or practically limited to residential burglary in our study area. Fifth, the customary limitations associated with the use of police data apply here. Police data are not collected for the purpose of research; therefore, they afford little information as to the accuracy of the information recorded (e.g., time of offence) or as to coding reliability (see Farrington & Lambert, 1997; for a discussion of police data reliability in the context of offender profiling). However, we concur with other crime linkage researchers that in natural conditions any crime linkage system would be reliant on police data; hence, studies in this domain should make use of the self-same police data, flaws and all, if they aim to be of practical relevance (e.g., Bennell & Canter, 2002).

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[4] *From a methodological perspective, in this study the TIC offences are used to generate the (null) distribution against which the observed patterns are compared, and hence any problems associated with the inclusion of TICs in this study will be minimized relative to other approaches to analysis, such as logistic regression.*

To conclude, our findings suggest that offenders exhibit consistency in the way they commit offences, but that for some aspects of their MO they often fail to display the specificity that would be necessary for accurate crime linkage analysis. While none of this contradicts most previous research in residential burglary linkage specifically, or crime linkage generally, there is inherent value in replicating these findings through an analytical methodology which allows for the conceptual separation between, and more direct tests of, the consistency and specificity hypotheses, and their respective theoretical underpinnings. More importantly, our results demonstrate that patterns are not homogeneous across offenders. Looked at through the prism of their entire series, some offenders exhibit more specificity than do others. Around one quarter of the offenders in the sample exhibited significant specificity, even for those types of MO for which offenders are, in the aggregate, the least specific, committing offences across their series in ways that differed from the rest of the sample of offenders. Crime linkage analysis offers the most potential for these offenders, and hence identifying which crimes are likely to be the work of offenders who display more specificity *a priori* constitutes a major challenge for future research of this kind. Looking further, more fundamental questions are raised regarding the explanation behind these differences among the offender population.

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References

ACPO & CPS (2007). *Prosecution Team Guidance: Offences to be taken into consideration*. Retrieved from http://www.cps.gov.uk/legal/assets/uploads/files/chapter_o_ptg.pdf

Baudains, P., Braithwaite, A., & Johnson, S. D. (2013). Target choice during extreme events: A discrete spatial choice model of the 2011 London riots. *Criminology*, *51*, 251–285. doi:10.1111/1745-9125.12004

Bennell, C., & Canter, D. V. (2002). Linking commercial burglaries by modus operandi: Tests using regression and ROC analysis. *Science and Justice*, *42*, 1–12. doi:10.1016/S1355-0306(02)71820-0

Bennell, C., & Jones, N. (2005). A method for linking serial burglaries by modus operandi. *International Journal of Investigative Psychology and Offender Profiling*, *2*, 23–41. doi:10.1002/jip.21

Bennell, C., Jones, N. J., & Melnyk, T. (2009). Addressing problems with traditional crime linking methods using receiver operating characteristic analysis. *Legal and Criminological Psychology*, *14* (2), 293–310. doi:10.1348/135532508X349336

Bennell, C., Snook, B., Macdonald, S., House, J. C., & Taylor, P. J. (2012). Computerized crime linkage systems: A critical review and research agenda. *Criminal Justice and Behavior*, *39*, 620–634. doi:10.1177/0093854811435210

Bennett, T., & Wright, R. (1984). *Burglars on burglary*. Hampshire, UK: Gower.

Bernasco, W., & Block, R. (2009). Where offenders choose to attack: A discrete choice model of robberies in Chicago. *Criminology*, *47*, 93–130. doi:10.1111/j.1745-9125.2009.00140.x

Bernasco, W., & Kooistra, T. (2010). Effects of residential history on commercial robbers' crime location choices. *European Journal of Criminology*, 7, 251–265. doi:10.1177/1477370810363372

Bernasco, W., & Nieuwbeerta, P. (2005). How do residential burglars select target areas? A new approach to the analysis of criminal location choice. *British Journal of Criminology*, *45*, 296–315. doi:10.1093/bjc/azh070

Blau, P. (1977). *Inequality and heterogeneity: A primitive theory of social structure*. New York, NY: Free Press.

Brantingham, P. L., & Brantingham, P. J. (1993). Environment, routine and situation: Toward a pattern theory of crime. In R. V. Clarke & M. Felson (Eds.), *Routine activity and rational choice* (pp. 259–294). New Brunswick, NJ: Transaction.

Budd, T. (2001). *Burglary: Practice messages from the British Crime Survey*. Home Office Briefing Note 5/01. London, UK: Home Office.

Canter, D. V. (1995). The psychology of offender profiling. In R. Bull & D. Carson (Eds.), *Handbook of psychology in legal contexts* (pp. 343–355). Chichester, UK: Wiley.

Canter, D. (2000). Offender profiling and criminal differentiation. *Legal and Criminological Psychology*, *5*, 23–46. doi:10.1348/135532500167958

Cohen, L. E., & Felson, M. (1979). Social change and crime rate trends: A routine activities approach. *American Sociological Review*, *44* (4), 588–607. doi:10.2307/2094589

Coupe, T., & Blake, L. (2006). Daylight and darkness targeting strategies and the risks of being seen at residential burglaries. *Criminology*, *44*, 431–464. doi:10.1111/j.1745-9125.2006.00054.x

Cromwell, P., Olson, J., & Avary, D. (1991). *Breaking and entering: An ethnographic analysis of burglary*. Newbury Park, CA: Sage.

Davies, A. (1991). The use of DNA profiling and behavioural science in the investigation of sexual offences. *Medicine, Science and Law*, *31*, 95–101. doi:10.1177/002580249103100202

Davies, K., Tonkin, M., Bull, R., & Bond, J. W. (2012). The course of crime linkage never did run smooth: A new investigation to tackle behavioural changes in serial car theft. *Journal of Investigative Psychology and Offender Profiling*, *9*, 274–295. doi:10.1002/jip.1369

Douglas, J. E., & Munn, C. (1992). Modus operandi and the signature aspect of violent crime. In J. E. Douglas, A. W. Burgess, A. G. Burgess & R. K. Ressler (Eds.), *Crime classification manual* (pp. 259–268). Lexington, MA: Lexington.

Ekblom, P., & Tilley, N. (2000). Going equipped: Criminology, situational crime prevention and the resourceful offender. *British Journal of Criminology*, *40*, 376–398. doi:10.1093/bjc/40.3.376

Farrington, D. P. (1994). Human development and criminal careers. In M. Maguire, R. Morgan & R. Reiner (Eds.), *The Oxford handbook of criminology* (pp. 511–584). Oxford, UK: Clarendon Press.

Farrington, D. P. (2003). Key results from the first forty years of the Cambridge study in delinquent development. In T. Thornberry & M. Krohn (Eds.), *Taking stock of delinquency* (pp. 137–183). Boston, MA: Kluwer.

Farrington, D. P., & Lambert, S. (1997). Predicting offenders profiles from victim and witness descriptions. In J. L. Jackson & D. A. Bekerian (Eds.), *Offender profiling: Theory, research and practice* (pp. 133–158). Hoboken, NJ: John Wiley & Sons.

Godwin, M. (Ed.) (2001). *Criminal psychology and forensic technology: A collaborative approach to effective profiling*. Boca Raton, FL: CRC Press.

Goodwill, A. M., & Alison, L. J. (2006). The development of a filter model for prioritizing suspects in burglary offences. *Psychology, Crime and Law*, *12* (4), 395–416. doi:10.1080/10683160500056945

Gottfredson, M. R., & Hirschi, T. (1990). *A general theory of crime*. Stanford, CA: Stanford University Press.

Grubin, D., Kelly, P., & Ayis, A. S. (1997). *Linking serious sexual assaults*. London, UK: Home Office: Police Research Group.

Hakim, S., Rengert, G. F., & Shachmurove, Y. (2001). Target search of burglars: A revised economic model. *Regional Science*, *80*, 121–137. doi:10.1111/j.1435-5597.2001.tb01791.x

Harbers, E., Deslauriers-Varin, N., Beauregard, E., & van der Kemp, J. J. (2012). Testing the behavioural and environmental consistency of serial sex offenders: A signature approach. *Journal of Investigative Psychology and Offender Profiling*, *9*, 259–273. doi:10.1002/jip.1368

Hearnden, I., & Magill, C. (2004). *Decision-making by house burglars: Offenders' perspectives, Home Office Research Findings 249*. London, UK: Home Office.

Hirschfield, A. F. G., & Bowers, K. J. (1997). The effect of social cohesion on levels of recorded crime in disadvantaged areas. *Urban Studies*, *34* (8), 1275–1295. doi:10.1080/0042098975637

Hochstetler, A. (2002). Sprees and runs: The construction of opportunity in criminal episodes. *Deviant Behavior*, *23*, 45–74. doi:10.1080/016396202317192026

Home Office (2011). *User guide to home office crime statistics*. London, UK: Home Office.

Hunter, P. R., & Gaston, M. A. (1988). Numerical index of the discriminatory ability of typing systems: An application of Simpson's index of diversity. *Journal of clinical microbiology*, *26* (11), 2465–2466.

Innes, M., Fielding, N., & Cope, N. (2005). The appliance of science? The theory and practice of crime intelligence analysis. *British Journal of Criminology*, *45*, 39–57. doi:10.1093/bjc/azh053

Jacobson, J., Maitland, L., & Hough, M. (2003). *The reducing burglary initiative: Investigating burglary. Home Office Research Study 26*. London, UK: Home Office.

Johnson, S. D., & Bowers, K. J. (2004). The burglary as clue to the future: The beginnings of prospective hot-Spotting. *European Journal of Criminology*, *1*, 237–255. doi:10.1177/1477370804041252

Johnson, S. D., Summers, L., & Pease, K. (2009). Offender as forager? A direct test of the boost account of victimization. *Journal of Quantitative Criminology*, *25*, 181–200. doi:10.1007/s10940-008-9060-8

Maguire, E. M. W. (1982). *Burglary in a dwelling*. London, UK: Heinemann Educational Books.

Markson, L., Woodhams, J., & Bond, J. W. (2010). Linking serial residential burglary: Comparing the utility of modus operandi behaviours, geographical proximity, and temporal proximity. *Journal of Investigative Psychology and Offender Profiling*, *7*, 91–107. doi:10.1002/jip.120

Nee, C., & Meenaghan, A. (2006). Expert decision making in burglars. *British Journal of Criminology*, *46*, 935–949. doi:10.1093/bjc/azl013

Nee, C., & Taylor, M. (1988). Residential burglary in the Republic of Ireland. In M. Tomlinson, T. Varley & C. McCullagh (Eds.), *Whose law and order* (pp. 82–103). Galway, Ireland: The Sociological Association of Ireland.

North, B. V., Curtis, D., & Sham, P. C. (2002). A note on the calculation of empirical p values from Monte Carlo procedures. *American Journal of Human Genetics*, *71*, 439–441. doi:10.1086/341527

Palmer, E. J., Holmes, A., & Hollin, C. R. (2002). Investigating burglars' decisions factors influencing target choice, method of entry, reasons for offending, repeat victimisation of a property and victim awareness. *Security Journal*, *15*, 7–18. doi:10.1057/palgrave.sj.8340101

Rengert, G.F., & Wasilchick, J. (1985). *Suburban burglary: A time and a place for everything*. Springfield, IL: Charles Thomas.

Rengert, G., & Wasilchick, J. (1989). *Space, time, and crime: Ethnographic Insights into residential burglary*. Washington, DC: National Institute of Justice.

Salo, B., Sirén, J., Corander, J., Zappalà, A. B. D., Mokros, A., & Santtila, P. (2013). Using Bayes' theorem in behavioural crime linking of serial homicide. *Legal and Criminological Psychology*, *18*, 356–370. doi:10.1111/j.2044-8333.2011.02043.x

Santtila, P., Junkkila, J., & Sandnabba, N. K. (2005). Behavioural linking of stranger rapes. *Journal of Investigative Psychologyand Offender Profling*, *2* (2), 87–103. doi:10.1002/jip.26

Shannon, C. (1948). A mathematical theory of communication. *The Bell System Technical Journal*, *27*, 379–423. doi:10.1002/j.1538-7305.1948.tb00917.x

Simpson, E. H. (1949). Measurement of diversity. *Nature*, *163*, 688. doi:10.1038/163688a0

Sorochinski, M., & Salfati, G. C. (2010). The consistency of inconsistency in serial homicide: Patterns of behavioural change across series. *Journal of Investigative Psychology and Offender Profiling*, *7*, 109–136. doi:10.1002/jip.118

Summers, L., Johnson, S. D., & Rengert, G. (2010). The use of maps in offender interviews. In W. Bernasco (Ed.), *Offender on offending: Learning about crime from criminals* (pp. 246–272). Cullompton, UK: Willan.

Tonkin, M., Santtila, P., & Bull, R. (2011). The linking of burglary crimes using offender behaviour: Testing research cross-nationally and exploring methodology. *Legal and Criminological Psychology*, *17*, 276–293. doi:10.1111/j.2044-8333.2010.02007.x

Tonkin, M., Woodhams, J., Bull, R., & Bond, J. W. (2012). Behavioural case linkage with solved and unsolved crimes. *Forensic Science International*, *222*, 146–153. doi:10.1016/j.forsciint.2012.05.017

Tonkin, M., Woodhams, J., Bull, R., Bond, J. W., & Palmer, E. J. (2011). Linking different types of crime using geographical and temporal proximity. *Criminal Justice and Behavior*, *38*, 1069–1088. doi:10.1177/0093854811418599

Townsley, M., & Sidebottom, A. (2010). All offenders are equal, but some are more equal than others: Variation in journeys to crime between offenders. *Criminology*, *48* (3), 897–917. doi:10.1111/j.1745-9125.2010.00205.x

Tunnell, K. (1992). *Choosing crime: The criminal calculus of property offenders*. Chicago, IL: Nelson-Hall.

Turvey, B. E. (2002). *Criminal profiling: An introduction to behavioral evidence analysis* (2nd ed.). London, UK: Academic Press.

Wikström, P.-O. H. (2006). Individuals, settings and acts of crime. Situational mechanisms and the explanation of crime. In P.-O. H. Wikström & R. Sampson (Eds.), *The explanation of crime: Context, mechanisms and development* (pp. 61–107). Cambridge, UK: Cambridge University Press.

Wiles, P., & Costello, A. (2000). *The road to nowhere: The evidence for travelling criminals*. Home Office Research Study 207. London, UK: Home Office.

Wolfgang, M., Figlio, R., & Sellin, T. (1972). *Delinquency in a birth cohort*. Chicago, IL: University of Chicago Press.

Woodhams, J., Hollin, C. R., & Bull, R. (2007). The psychology of linking crimes: A review of the evidence. *Legal and Criminological Psychology*, *12*, 233–249. doi:10.1348/135532506X118631

Woodhams, J., Hollin, C. R., & Bull, R. (2008). Incorporating context in linking crimes: An exploratory study of situational similarity and if-then contingencies. *Journal of Investigative Psychology and Offender Profiling*, *5*, 1–23. doi:10.1002/jip.75

Woodhams, J., & Labuschagne, G. (2011). A test of case linkage principles with solved and unsolved serial rapes. *Journal of Police and Criminal Psychology*, *27*, 85–98. doi:10.1007/s11896-011-9091-1

Woodhams, J., & Toye, K. (2007). An empirical test of the assumptions of case linkage and offender profiling with serial commercial robberies. *Psychology, Public Policy, and Law*, *13* (1), 59–85. doi:10.1037/1076-8971.13.1.59

Wright, R., & Decker, S. (1994). *Burglars on the job: Streetlife and residential breakins*. Boston, MA: Northeastern University Press.

Wright, R., Logie, R. H., & Decker, S. H. (1995). Criminal expertise and offender decision making: An experimental study of the target selection process in residential burglary. *Journal of Research in Crime and Delinquency*, *32*, 39–53. doi:10.1177/0022427895032001002

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Supporting Information

The following supporting information may be found in the online edition of the article:

Appendix S1. Categories of modus operandi and their frequency of occurrence (values in parentheses indicate the number of offences for which data were available).