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Using offender crime scene behavior to link stranger sexual assaults: A comparison of three statistical approaches

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ABSTRACT

Purpose: This study compared the utility of different statistical methods in differentiating sexual crimes committed by the same person from sexual crimes committed by different persons.
Methods: Logistic regression, iterative classification tree (ICT), and Bayesian analysis were applied to a dataset of 3,364 solved, unsolved, serial, and apparent one-off sexual assaults committed in five countries. Receiver Operating Characteristic analysis was used to compare the statistical approaches.
Results: All approaches achieved statistically significant levels of discrimination accuracy. Two out of three Bayesian methods achieved a statistically higher level of accuracy (Areas Under the Curve [AUC] = 0.89 [Bayesian coding method 1]; AUC = 0.91 [Bayesian coding method 3]) than ICT analysis (AUC = 0.88), logistic regression (AUC = 0.87), and Bayesian coding method 2 (AUC = 0.86).
Conclusions: The ability to capture/utilize between-offender differences in behavioral consistency appear to be of benefit when linking sexual offenses. Statistical approaches that utilize individual offender behaviors when generating crime linkage predictions may be preferable to approaches that rely on a single summary score of behavioral similarity. Crime linkage decision-support tools should incorporate a range of statistical methods and future research must compare these methods in terms of accuracy, usability, and suitability for practice.

1. Introduction

One of the most well documented findings in criminology is that the majority of crime is committed by a minority of serial offenders who impose significant costs on society (e.g., Piquero, Farrington, & Blumstein, 2007). Estimates suggest, for example, that 6–10% of offenders are responsible for more than half of all crime committed in the United States (US) and the United Kingdom (UK) (Dodd, Nicholas, Povey, & Walker, 2004; Wolfgang, Figlio, & Sellin, 1972), with the average career criminal costing society more than $1.14 million during their lifetime (DeLisi & Gatling, 2003). Developing methods for catching and convicting serial offenders is, therefore, a significant priority for the criminal justice system.

To tackle serial offending effectively, methods must be developed to

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identify so-called linked crime series, which consist of two or more crimes that have been committed by the same offender or the same group of offenders (Woodhams, Hollin, & Bull, 2007c). In the absence of physical trace material (e.g., DNA) to link crime scenes, it has been suggested that similarity in offender crime scene behavior might be used (e.g., Bennell & Jones, 2005; Burrell, Bull, & Bond, 2012; Woodhams & Toye, 2007). The assumption is that crimes committed in a similar way behaviorally (e.g., using a similar level and type of violence, similar methods of controlling the victim, etc.) might be categorized as linked (i.e., committed by the same person) whereas crimes constituting very different behavior might be categorized as unlinked (i.e., committed by different persons) (Bennell & Canter, 2002). This procedure has been referred to using various names, including crime linkage, behavioral case linkage, comparative case analysis, and crime linkage analysis.[1] The term crime linkage will be used throughout the current article.

If crimes can be accurately linked, crime linkage affords a number of potential benefits to criminal justice agencies. First, it allows the evidence collected across several investigations to be pooled, which can increase the quantity and quality of evidence available with which to catch and convict serial offenders (Grubin, Kelly, & Brunsdon, 2001). Second, the ability to link multiple crimes to a single offender enables the police to combine different investigations, thereby helping to avoid duplication of roles, responsibilities, and investigative work that would occur if these crimes were investigated separately (Woodhams, Hollin & Bull, 2007c). Ultimately, this creates a more efficient and streamlined investigative process (Woodhams, Hollin & Bull, 2007c), which is of significant benefit at a time when law enforcement agencies are facing considerable budget cuts and resource constraints. Third, when crimes are successfully linked, it has been suggested that each individual victim gains confidence and credibility from the others, thereby increasing the likelihood that cases will successfully reach court (Davies, 1992). This is particularly important for sexual crimes where it is estimated that only six out of every 1000 rapists in the US will be incarcerated and high levels of attrition are reported at all levels of the criminal justice process.[2]

Given these potential benefits, it is unsurprising that law enforcement units have been established around the world to facilitate the behavioral analysis of crime (including crime linkage). For example, such units have been established in the UK, the US, Canada, Belgium, the Netherlands, South Africa, Germany, Japan, New Zealand, France, the Czech Republic, and Switzerland (to name but a few countries). For a variety of reasons, however, the task of crime linkage is a considerable challenge for criminal justice practitioners. Crime linkage involves a number of analytical steps (as outlined by Woodhams, Bull, & Hollin, 2007a), including identifying the offender behaviors present in a given crime (of which there can be many; Bennell, Bloomfield, Snook, Taylor & Barnes, 2010a), identifying behavioral similarities and differences across multiple crimes, considering situational circumstances and base rates,[3] and then summarizing this information in a written and/or verbal report. This process might involve sifting through hundreds, possibly thousands, of crimes to identify offenses that share similar offender behaviors.[4] Crime linkage is, therefore, a process that can be very time-consuming and can place considerable cognitive load on criminal justice practitioners (Santtila, Korpela, & Häkkänen, 2004).

One approach to overcoming (or at least partially addressing) the challenges associated with crime linkage is to develop computerized decision-support tools that can analyze vast quantities of crime scene information in a quick and efficient manner. These tools would then provide the practitioner with a prioritized list of potentially linked crimes for further investigation/analysis and a simple, easy-to-process summary of the behavioral similarities and differences between these various crimes (e.g., Canter & Youngs, 2008; Grubin et al., 2001; Oatley, Ewart, & Zeleznikow, 2006; Woodhams et al., 2007a). Such tools might help to reduce the cognitive load on analysts when they are conducting crime linkage, which would be beneficial because excessive load has been shown to hamper performance and lead to decision-making errors in a variety of contexts (e.g., see Adcock, 2000, for a review). Furthermore, computerized decision-support tools that automate certain parts of the analytical process might increase the efficiency of crime linkage units, allowing them to analyze more cases (in less time) than they are currently able to. This would help criminal justice agencies to continue meeting operational demand despite decreasing resources.

Over the last decade, a growing body of research has sought to develop statistical methods that might underpin computerized crime linkage support tools (e.g., Bennell & Jones, 2005; Burrell et al., 2012; Ellingwood, Mugford, Bennell, Melnyk, & Fritzon, 2013; Santtila et al., 2005; Santtila et al., 2008; Tonkin, Grant, & Bond, 2008; Winter et al., 2013; Woodhams & Labuschagne, 2012; Woodhams & Toye, 2007; Yokota, Fujita, Watanabe, Yoshimoto, & Wachi, 2007). These studies have found support for the two theoretical assumptions that underpin crime linkage (behavioral consistency and distinctiveness[5]) and have demonstrated moderate to high levels of accuracy when using offender crime scene behavior to distinguish between linked and unlinked offenses (see Bennell, Mugford, Ellingwood, & Woodhams, 2014, for a review). Within this literature, a range of statistical methods have been explored, including (but not limited to) logistic regression, classification tree analysis, and Bayesian analysis. There are, however, very few studies that have drawn direct comparisons between different statistical approaches. Consequently, it is not possible to determine from existing literature which (out of the many available statistical methods; Bennell, Goodwill, & Chinneck, 2015) is the most suitable/offers the greatest potential for supporting the development of computerized crime linkage decision-support tools. Ultimately, this is preventing researchers from developing evidence-based tools, thereby limiting the value of existing research to criminal justice practitioners.

The current study aims to overcome this fundamental limitation by comparing a variety of statistical methods in terms of their ability to distinguish between linked and unlinked crimes (referred to hereafter as discrimination accuracy). This follows a methodology originally developed by Bennell (2002), which has since been adopted in

[1] It is important to note that often these terms are used inter-changeably, but some scholars use these terms to refer to distinctly different analytical processes (see Rainbow, 2015).

[2] This estimate is based on a range of sources summarized at: https://www.rainn.org/statistics/criminal-justice-system

[3] In judging whether a behavioral similarity/difference is useful for determining crime linkage status (linked/unlinked), the practitioner must consider situational circumstances. For example, apparent behavioral differences between two crimes might be explained by the fact an offender was interrupted in one crime but not the other, and the interruption forced the offender to alter his/her behavior. In which case, the differences might not be considered that useful by the practitioner. When considering whether a given behavioral similarity is useful, the practitioner must consider base rate information indicating how frequently given behaviors occur in a particular type of crime. That is, it is perhaps not that useful if the behaviors shared across two crimes consist only of behaviors that are very common to that particular type of offense (e.g., vaginal penetration from the front is common in sexual offenses; Santtila, Junkkila, & Sandnabba, 2005; Winter et al., 2013). It is much more useful if relatively rare behaviors are shared across several crimes, and in such a situation it would be more likely that one would conclude that the two crimes were linked.

(*footnote continued*)

[4] For example, the unit responsible for conducting crime linkage with sexual offenses in the UK, the Serious Crime Analysis Section (SCAS), hold a database containing over 25,000 offenses within which their analysts must search for potentially linked crimes.

[5] In order for crime linkage to function reliably and accurately, offenders must repeat certain elements of their offending behavior from one offense to the next (behavioral consistency) and there must be individual differences between offenders in the way that they commit crime (behavioral distinctiveness), otherwise it will not be possible to distinguish the crimes of one offender from those of another (Woodhams, Hollin & Bull, 2007c).