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TECHNICAL NOTE

CRIMINALISTICS; GENERAL

Amy C. Shuttlewood,[1] *M.Sc.; John W. Bond,*[2] *D.Phil.; and Lisa L. Smith,*[1] *M.Sc.*

The Relationship Between Deprivation and Forensic Material Recovered from Stolen Vehicles: Is it Affected by Vehicle Condition and Tidiness?

ABSTRACT: Previous research has shown that as crime scene location deprivation increases (lower socioeconomic status), the recovery of forensic material, principally DNA and fingerprints, also increases. However, this increase does not result in more crimes being solved by forensic means. In this study, we analyze stolen vehicle data and find a statistically significant positive association between deprivation and the amount of forensic material that matched either the victim or an associate of the victim on a criminal database. The nature of this association was investigated further by inspecting recovered stolen vehicles to establish whether the condition of a stolen vehicle and the tidiness of its interior influenced the recovery of forensic material that was attributed to the victim or an associate. Contradictory results suggest that other factors may contribute to understanding the association between the recovery of victim- or associate-attributable forensic material and crime scene location deprivation.

KEYWORDS: forensic science, DNA, fingerprints, deprivation, crime scene, criminalistics, socioeconomic status

Forensic intelligence, such as DNA and fingerprint identifications, is regarded as an important method of improving the rate of crimes solved, contributing to investigations of all types of crimes ranging from burglary to major crimes, such as murder (1,2). The increasing use of forensic techniques and scene attendance rates in the U.K. and U.S.A. by crime scene investigators at volume crime scenes (e.g., all car crime and burglary) has increased the number of vehicle thefts being solved (3). In support of this, researchers found that one-quarter of burglary and auto crimes solved were aided by the forensic material recovered at the scene (4).

The processing of forensic material recovered from a crime scene may result in an identification being made to a suspect, which then leads to an arrest. The suspect will be interviewed and asked to explain why their DNA or fingerprints were found at the crime scene and then subsequently charged if they do not provide a satisfactory account. The case is then recorded as solved and closed (5). However, forensic evidence is now used increasingly not just to add to existing prosecuting evidence about known offenders but also to identify unknown offenders (3).

In the U.K. the theft of a motor vehicle is an increasing problem with almost 1.5 million thefts recorded in 2007–2008. However, this figure has dropped by 11% when compared to the recorded crimes of the previous year (6). In October 2005, Northamptonshire Police (U.K.) stated that the proportion of vehicle-related crimes solved had increased from 26% to 47% (7).

[1]University of Leicester, School of Psychology, Forensic Section, 106 New Walk, Leicester, LE1 7EA, U.K.
[2]Scientific Support Department, Northamptonshire Police, Wootton Hall, Northampton, England NN4 0JQ. Also at: Forensic Research Centre, University of Leicester, Leicester LE1 7EA, U.K.

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Adderley and Bond (8) found a relationship between the deprivation of a crime scene and the quantity of forensic material recovered. This study analyzed all volume crime types, such as burglary, theft of vehicles, and theft from vehicles. More specifically, the more deprived the crime scene location, the more DNA and fingerprint material was recovered. However, this was only statistically significant for DNA material recovered and not for fingerprints recovered (8). The deprivation of a location was derived from data produced by the U.K. government that included seven different factors of deprivation: employment deprivation, education, health deprivation and disability, income deprivation, living environment deprivation and crime, skills and training deprivation, and barriers to housing and services. All seven of these areas were collated to generate the aggregate measure of deprivation, known as the deprivation score (9). Thus, deprivation provides a quantifiable measure of what, in the U.S. and elsewhere, is more commonly referred to as socioeconomic status (SES). These two terms are, in fact, the inverse of each other as a high deprivation score equates to a low SES.

Following on from the study completed by Adderley and Bond (8), researchers analyzed the crime types burglary, theft from a vehicle, and theft of a vehicle, separately. They found a statistically significant relationship between the recovery of forensic material for stolen vehicles and the deprivation of the crime scene location (5). The results indicated that an increase in deprivation was associated with an increase in the recovery of DNA and fingerprints (5). However, this did not lead to an increase in the number of crimes being solved by forensic means.

Blackburn (10) explains that low SES is a significant predictor of criminal behavior. Similarly, it has been concluded that offender characteristics associated with vehicle crime include SES and age, with the majority of vehicle thefts being committed by men under

the age of 21 (11). Therefore, it can be reasonably concluded that those individuals in more deprived areas are more likely to have previous involvement in criminal activities. As a result of previous criminal involvement, these individuals are more likely to have their fingerprints and DNA stored in a criminal database. It is argued by the U.K. government that holding DNA and fingerprint data on the database "pursues the legitimate purpose of the detection, and therefore, prevention of crime" (6, p. 8). This can then explain why an increase in forensic identifications in deprived areas is not associated with an increase in solved crimes, because the victim is more likely to be on the database and is not the offender. As Smith and Bond (5) suggested, the increase in forensic material recovery in more deprived areas may be attributable to the recovery of material belonging to the victim or an associate of the victim, and this is more likely to produce an identification on a criminal database for crimes in deprived areas.

It has also been suggested that in more deprived areas, lower vehicles are more likely to be in a much poorer condition (including more untidy) than those in less deprived areas, thereby explaining why there might be more material for the crime scene investigator to recover (5). This study seeks to explain why there is not an increase in the number of crimes solved in more deprived areas when a significantly higher amount of forensic material is recovered for vehicle theft in these areas. First, we test Smith and Bond's (5) hypothesis that in more deprived areas (lower SES), there is an increase in the recovery of forensic material belonging to the victim or an associate. We then investigate the condition (tidiness) of the vehicle. It is hypothesized that stolen vehicles recovered from more deprived areas will be untidier when compared to stolen vehicles recovered from lesser deprived areas.

Method

Design

This study used data recorded by Northamptonshire Police (U.K.) of crime scenes attended by a crime scene investigator between April 2007 and March 2008. The data only included vehicle crimes categorized as theft of motor vehicles making a total of 402 attended crime scenes. A deprivation score was available for all districts in Northamptonshire.

The dependent variable was the deprivation score of the area the vehicle was stolen from. Three independent variables represented whether the forensic material was coded as belonging to either the victim or an associate of the victim of no evidential value or crime solved. No evidential value refers to cases where there was insufficient prosecuting evidence or that the suspect provided a plausible account for their DNA and/or fingerprints being found. Victim or associate was used when the forensic material was identified to either the victim or a person known to the victim that was given legitimate use of the vehicle. Crime solved was used when the crime was solved as a result of the forensic material recovered.

Materials and Data Sources

The data recorded by Northamptonshire Police consisted of the following:

- Crime reference number.
- District where the vehicle was stolen from (crime scene location).
- Type of forensic material recovered (DNA and/or fingerprints).
- Forensic result, for example, if an identification was made and how this was then resolved.

Vehicle inspection checklists were completed for 12 recovered stolen vehicles, which were available over a 2-month period during which this part of the study was conducted. The checklists consisted of questions relating to the condition of the vehicle involving the quantity of cigarette butts, food and drink containers, and paper waste in the vehicle. Each checklist was completed while a crime scene investigator was examining the vehicle, and this ensured that the researcher knew whether items were taken for forensic examination. Information was collected for all checklists including the area the car was stolen from and the relevant deprivation score.

Following completion of the checklists, information was sought regarding the type of forensic material recovered by the crime scene investigator, whether it was DNA and/or fingerprints. Information was then gathered regarding how each crime had been resolved once the forensic material had been analyzed, for example, if a suspect had been charged.

Procedure

The checklist was completed by looking into a vehicle to inspect the type and amount of rubbish/debris stored in the vehicle.

The checklists were coded and inputted into an Excel spreadsheet and SPSS (IBM(SPSS), Chicago, IL) for descriptive statistics to be obtained. Each item on the checklist was coded, except for the number of cigarette butts found as this was zero for all cars examined. Other items on the checklist included the amount of food/drink containers found in the vehicle, the type of debris found, the number of stains found, and the overall cleanliness of the interior and exterior of the vehicle. Each checklist was followed up to ascertain whether DNA and/or fingerprints were recovered.

Data were then coded into SPSS along with how each case was resolved and then analyzed using a one-way analysis of variance (ANOVA) and results interpreted.

Results

The data were analyzed in particular for those crimes resulted as "no evidential value" to determine the reasons why the forensic material was insufficient for prosecution. The most common of these reasons was that the DNA was recovered from a moveable object, and there was insufficient evidence to prove the suspect actually stole the vehicle (12). This was also the result if fingerprints were found on the exterior of the vehicle. Although this contributes to police intelligence, it does not prove the suspect stole the vehicle (12). Also, if the suspect provided a plausible account to how their DNA and/or fingerprints were found in the vehicle and there was no other evidence linking them to the crime, no further action was taken to prosecute the suspect. Other reasons included an uncooperative victim or insufficient evidence.

A one-way ANOVA was performed on data for stolen vehicles recovered between April 2007 and March 2008. Post hoc tests, using the Bonferroni correction, were used to determine the significant differences between the groups. Descriptive statistics including the mean deprivation score and standard deviation were calculated for all three levels of the independent variable as listed in Table 1.

There was a significant difference in the deprivation scores between two outcome categories: victim or associate and crime solved, $F(2, 400) = 4.05$, $p < 0.05$. This result shows that the deprivation score is significantly higher (lower SES) for the crimes resulted as victim or associate compared to crimes resulted as crime solved. The effect size was calculated using the between-group effect divided by the total amount of variance in the data. The square root was taken on this value and produced a weak

effect size, $r = 0.14$. Therefore, the effect of the outcome on deprivation score was not found to be a substantive result (13).

The deprivation scores were grouped in Fig. 1 to better demonstrate the association between the victim or associate result and the deprivation score. This is because attempting to display the data graphically did not demonstrate a clear representation of the data. Therefore, using a k-means clustering algorithm (8), deprivation scores were organized into five equal-sized groups, or bands, giving a clearer representation of the deprivation and the percentage of victim or associate results. Figure 1 below displays this association showing a strong relationship, $R^2 = 0.67$, $p < 0.05$. The results also showed that the higher the deprivation score, fewer crimes were solved, which replicates the findings of Smith and Bond (5).

With regard to the cleanliness of the vehicle, descriptive statistics were summarized for the deprivation score, the cleanliness of the vehicle, and the forensic material recovered. The deprivation score ranged from 7.49 to one of the highest deprived areas scoring 39.85. The mean deprivation score was calculated as 20.05 with a standard deviation of 9.80. The mean deprivation score for the recovery of DNA was found to be 19.82, and for the recovery of fingerprints, a mean deprivation score of 18.04 was found.

Table 2 demonstrates a general overview of the stolen vehicles examined, displaying the deprivation score, the type of evidence recovered at the scene, the degree and extent of rubbish found in the car, and how this case was resolved.

From reviewing these checklists, it is not clear how much of an influence the condition of the vehicle has on the outcome (i.e., forensic material result) of each crime scene. Clearly, there are insufficient checklists completed with forensic outcomes to make a direct comparison. However, the highest deprived scene scoring 39.85 had the highest number of drink and food containers and paper waste. Even though DNA and fingerprints were submitted for this scene, both results came back negative with no identifications found on the criminal database. Therefore, this forensic material could have identified a potential unknown offender. Nevertheless, when looking at vehicles that were categorized as 'like new' and had no rubbish inside the vehicle whatsoever, these were still from fairly deprived areas, displaying deprivation scores of 29.99. Also, there are other discrepancies that do not match with previous assumptions of dirty cars being from highly deprived areas. For the two stolen cars that were categorized as 'fairly dirty', these were from very less deprived areas (higher SES) with IMD scores of 11.42 and 7.49.

TABLE 1—*The number, means, and standard deviations of the three outcome categories.*

	N	Mean	SD
Victim or associate	118	24.75_a	10.37
No evidential value	131	22.15_a	9.83
Offense solved	154	21.36_b	9.84

Subscripts indicate a significant difference between victim or associate and offense solved at the $p < 0.05$ significance level.

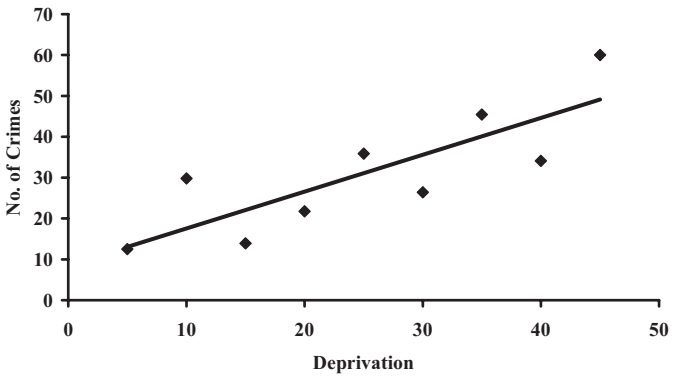

FIG. 1—*Number of crimes resulted as victim or associate plotted against crime scene location deprivation score. The solid line shows a least squares regression analysis with* $R^2 = 0.67$, $p < 0.05$.

Discussion

This research found a significant difference between the deprivation score of the area the vehicle was stolen from and two forensic material results: victim or associate and crime solved. This indicates that as the deprivation score increases (lower SES), more forensic material (DNA and/or fingerprints) was recovered matching with the victim or an associate and thus producing a 'hit' on a criminal database. This therefore supports previous literature, which suggests that a low SES is a significant predictor of criminal involvement (10). This also explains the insufficient increase in crimes being solved, as forensic material recovered was more likely to belong to the victim. This supports previous research by Smith and Bond (2009) where the level of deprivation does not determine the level of crimes solved (5).

When analyzing the vehicle inspection checklists, it was found that the most deprived crime scene had the most contents of rubbish in the vehicle. No identifications were found for DNA and fingerprints recovered at the scene; however, it does potentially confirm previous assumptions that the more deprived the area, the dirtier the vehicle (5). It was also found that other assumptions were proved incorrect with some dirtier vehicles being from less deprived areas. This sample was limited in numbers, which therefore limits its generalizability.

Smith and Bond (2009) concluded that more deprived areas generate more forensic material but they also yield more forensic intelligence (5). However, although more forensic material is recovered in deprived areas, this does not mean that more crimes are solved. There are several possible explanations to attempt to understand why more crimes are not being solved if more forensic material is

TABLE 2—*The results of the vehicle inspection checklists displaying the detailed condition of the vehicles and how each crime scene was subsequently resulted.*

			Number of			
Outcome	Deprivation	Evidence Type	Drink Containers	Food Containers	Paper Waste	Cleanliness of Vehicle
1	23.93	D/F	<3	0	0	Clean
1	29.99	D/F	0	0	0	Like new
1	8.52	D/F	0	0	<3	Clean
1	23.93	D/F	0	<3	>6	Average
1	39.85	D/F	≤3, ≥6	>6	>6	Average
1	11.42	F	<3	>6	≤3, ≥6	Average
1	11.42	D/F	<3	0	<3	Dirty
1	15.87	D/F	0	<3	≤3, ≥6	Clean
1	7.49	D/F	<3	<3	>6	Dirty
2	29.99	D/F	0	0	0	Like new
2	26.85	D	0	<3	<3	Average
3	10.42	D/F	0	≤3, ≥6	0	Average

Outcome: 1, no matches to criminal database; 2, victim or associate; 3, no evidential value. D, DNA; F, fingerprints.

recovered. This research has investigated one possible explanation: whether the condition of the car impacts on the forensic material recovered.

As a result of conducting vehicle inspection checklists, crime scene investigators explained the problems they have in examining stolen vehicles. The main problem is the fact that offenders are more forensically aware than they used to be.

For example, it is now common sense to wear gloves to prevent fingerprints being left as evidence. If the stolen vehicle was in a very bad condition, it is very difficult for the crime scene investigator to eliminate what property is the victim's and what might belong to the perpetrator. This is especially the case if the crime scene investigator cannot make contact with the victim; it is difficult to know what evidence can be eliminated to the victim and the material that may potentially belong to the perpetrator. Therefore, if the victim is uncooperative or unobtainable, it is the crime scene investigator's judgment on what to take for examination. This can be influenced easily by their experience and length of time in their role and individual differences between crime scene investigators.

It was explained that if the outside of the vehicle is very dirty, fingerprints would only disturb the dirt and not actually leave a sufficient print to lift for evidence. The forensic recovery of materials depends on the amount of information given by the arresting officers and the circumstances of the crime, such as how the offenders got into the vehicle. Crime scene investigators can look more deeply for relevant material. Also, if the crime scene investigators are advised of the number of offenders, they know to search the back of the vehicle not just the driver's side. It was explained that if there is no sign of forced entry, the offenders must have broken into the property for the car keys, perhaps indicating greater intent and experience in criminal activities. This then suggests that the offender will not be inside the vehicle for a long period of time and that they will be more forensically aware and experienced enough not to leave evidence behind in the vehicle.

One of the limitations in researching this topic is the likelihood of a match being produced between the forensic material recovered and the existing criminal database to identify a suspect, not just the potential for forensic recovery (5). This is because many suspects will not be matched by their forensics if they have had no police involvement (e.g., a previous arrest) and as a result do not have their DNA or fingerprints on the criminal database.

There are various suggestions for future research including conducting a similar study but with a substantial number of vehicle inspection checklists so a statistical analysis can be produced. It will also be necessary to inspect vehicles that have been stolen from a wide range of areas displaying an even representation of deprivation scores. An issue not investigated in this study was the effect of where the vehicle was examined as some vehicles can be examined at the victim's home address, while others are inspected at a contracted garage. Examining a stolen vehicle with the victim present may provide more useful information for the crime scene investigator in terms of eliminating what material belongs to them or has the potential to match to a suspect. Other factors could then be investigated to determine whether there is an influence on the recovery of forensic material, such as the time spent examining the vehicle. This information could then be related to the deprivation of the crime scene to establish whether a relationship is present.

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Additional information and reprint requests:
John W. Bond, D.Phil.
Scientific Support Department
Northamptonshire Police
Wootton Hall
Northampton NN4 0JQ
U.K.
E-mail: john.bond@northants.police.uk