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# Using DNA to catch offenders quicker: Serious detections arising from Criminal Justice Samples.

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## Abstract

DNA samples on the national database matching those found at scenes of serious violent or sexual crimes were identified. The earlier offence leading the sample to appear on the database was noted. The bulk (60-84% according to inclusion criteria) involved theft, drug or other offending. The result, indicating offender versatility, is consistent with most research on criminal careers. Its importance for operational police lies in identifying the contribution made by DNA samples taken after less serious offences in clearing subsequent serious crime, and the importance of taking such samples as widely as possible. Examining specific relationships between early and later offences revealed a significant link between providing a DNA sample following a drug offence and subsequently committing murder.

## Background

In little under two decades, the use of DNA in the investigation of crime has become widespread. Since Sir Alec Jeffreys and colleagues pioneered what was first known as genetic fingerprinting (Jeffreys et al, 1985), advances in technology have allowed DNA profiling to be carried out at high speed and volume, at lower cost and with smaller crime scene samples, making its use in crime detection increasingly viable and appealing.

The England and Wales National DNA Database (NDNAD) has been impressive in scale, speed of development, and the protections it affords against false matches.[1] The technique's potential was anticipated from an early stage and received significant Government support. Large investments were made in populating the NDNAD (Williams and Johnson, 2003) and legislation was introduced to facilitate sampling of as many of the offending population as possible (Johnson et al., 2003). By increasing the number of putative offenders from whom samples are taken (hereinafter criminal justice samples), the probability of samples taken from scenes of crime being matched will increase, limited primarily by the churn rate of the active offending population, ie the rate of which people begin and end their active offending career.

The Home Office DNA Expansion Programme was launched in 1999, funded with £182 million between April 2000 and March 2004 (Forensic Science Service, 2003). The 1994 Criminal Justice and Public Order Act had previously enabled the police to take non-intimate samples without consent from all those charged (not necessarily arrested) with any recordable offence. The Act also reclassified a mouth swab as non-intimate, thereby removing the need to involve medical professionals for sample collection.

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[1] See http://www.forensic.gov.uk/forensic_t/inside/about/annual.htm for a complete set of annual reports. Accessed 25th Dec 2004.

Since the first record was entered in 1995, the NDNAD has grown to 2.35 million by July 2004[2]. With the 'active criminal population' in England and Wales estimated at 2.6 million people (Forensic Science Service, 2004; Johnson and Williams, 2003), the magnitude of the achievement is undeniable, although the notion that this means that ninety two percent of the active criminal population features on the database would be a substantial overestimate, because of the churn rate referred to above.

## Criminal Careers and Crime Switching

The term 'criminal career' refers to the offending trajectory of criminal behaviour, and its consistency and variation between and within offenders. The pertinent research literature deals with questions such as: Why do some people desist from crime and others continue? Are there people who do not stop offending at any stage of their lives? How does age and length of offending effect what crimes are committed?

Such questions are relevant to operational policing because they allow a detailed picture of the active offending population to be developed. Individual criminal careers are described in terms of a number of dimensions, notably length, offending rate, and offending patterns (primarily versatility and escalation). Combinations (long or short careers, high or low offending rates, specialisation or versatile) produce diverse patterns at the individual level. This information has the potential to inform strategy. For example, the estimated size of the offender population and the offending patterns within it should favour certain crime control strategies over others. If the offending population were relatively small but those active remained active over substantial periods of time and offended at a high rate, then the targeting of individuals by police would be an appropriate tactic. If the offending population were large and comprised people committing only a couple of offences each, preventive approaches would be more attractive. Of course the real world will contain a mixture of 'types', but their relative size will favour some reduction strategies over others.

Understanding of criminal careers has traditionally been acquired through analysis of convictions and other official processing of offenders. DNA affords another window on criminal careers, with some disadvantages relative to the conventional approach, but with advantages, for example the possibility of including 'prolific unknowns' ie those whose DNA is found at many crime scenes but not in the national DNA database. In this brief paper, an attempt is made to use DNA sampling to address the issue of offender specialisation and its policing implications.

The simplest way of addressing offender specialisation/versatility using NDNAD is to compare the offence which resulted in an offender having DNA taken (the criminal justice sample) with the offence at which matching DNA was subsequently found. If the two offences were always the same, specialisation would be total (within the limits of the data). If the two offences were no more alike than a pair taken randomly, one from criminal justice

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[2] http://www.forensic.gov.uk/forensic_t/inside/news/docs/NDNAD.doc accessed 24th Dec 2004.

samples, and one from crime scene samples, then versatility would be total, again within the limits of the data.

Recent analysis of DNA matches in England and Wales seems to suggest that offenders are, to a substantial degree, versatile in their offending behaviour. In 2002-2003, eighty percent of matches for criminal justice samples related to offences that were different from the initial arrest offence for which the criminal justice sample was taken (Forensic Science Service, 2003).

Having noted the potential of NDNAD in looking at offender careers, and that it has so far been scarcely realised, it must be asserted that previous research of the more conventional kind establishes a high degree of versatility in most criminal careers (see Blumstein et al., 1986, 1988; Wolfgang et al., 1987; Paternoster et al. 1998). Although debate exists about the precise level of specialisation exhibited by offenders, the degree of their versatility in both offence and method is substantial (see Bouhana 2003). It is difficult to overstate the implications of this for the targeting of prolific offenders, by forensic and by other means. Insofar as offenders are versatile, detection in one offence offers an opportunity for detection in subsequent offences of other types. The evidence for this comes from the detection of notorious offenders – for example the Yorkshire Ripper was brought to justice by his detection for stealing a number plate from a Dewsbury scrap yard. It also comes from research showing the high proportion of those committing trivial offences who are also involved in more serious offending (Kelling and Coles 1996; Chenery, Henshaw and Pease 2000). Schneider (in press) identifies the high rate of self-reported shop theft amongst active burglars. Wellsmith and Guille (in press) show the levels of active criminality in a sample of those repeatedly subject to fixed penalty notices.

There is an urgent need to begin looking at exactly what types of crime are linked with serious offending.  Are there indicator or precursor minor offences? If so then how can this knowledge be used to greater effect? The questions we propose to address are the following:

*What other types of crime do offenders committing a serious offence also commit?  What implications does the resolution of that question have for the practice of taking DNA samples from those coming into contact with the criminal justice system as putative minor offenders?*


## Data

We obtained data on all solved serious offences within the Metropolitan Police jurisdiction for the calendar year 2003.  The offence types were all cases of murder, manslaughter, attempted murder, sexual offences, rapes, various types of robbery.  This amounted to 9424 criminal matters. These events will be termed *index offences* in what follows.

Of these 9424 matters, some 11% yielded a crime scene sample which could be matched with an offender on the National Database, ie where a criminal justice sample had been taken at an earlier time, some 1003 matters in all. The

earlier event which led to the taking of a criminal justice sample will henceforth be referred to as the *precursor event.* Matching criminal justice samples from precursor events after April 2000 could be located very quickly. Those collected before April 2000 were stored on a separate database, and their extraction would have been extremely time-consuming, particularly for an unfunded study such as the one reported here. It was thus decided to use only those observations with a precursor event criminal justice sample collected after April 2000. The resulting sample size came to 492 observations, which was considered sufficient for our purposes.

The data fields obtained from the Metropolitan Police included information about each index offence: the crime reference number; crime type; date and police beat. For every record the precursor offence that was the origin of the corresponding criminal justice sample was recorded.

A few points about these data are worth making. First, there was no information about location and dates for the precursor offences, ie the offences whose perpetrator went on to commit a serious offence as defined above. It would be desirable to determine spatial patterns between precursor and index offences. The data precluded this avenue of analysis.

Second, links between index offences and precursor offences could only be supplied for precursor offences after April 2000. As criminal justice sampling, in principle, is meant to follow an individual's first detected recordable offence, the conclusions reached are limited to those with short criminal careers to date. The longest career represented in these data will be around three years. The study thus focuses on detections achievable by criminal justice sampling *in the short term*. This is important in its own right. Detections achieved in the longer term should be researched.

Third, it would be desirable to comment on and control for the criminal justice sampling rates of different offence types. This is feasible but is beyond the scope of this unfunded study.

The last qualifier about these data is that we have no information about the details of individual offences, apart from their type. Thus, we cannot make any inferences about any variation in the level of seriousness of index offences according to precursor offence type. Given that all the index offences are serious, this is not of immediately crucial importance, but should be explored in future work.


**Analysis**

The first step was to calculate the frequency distribution for the index and precursor offence types separately. The resulting distributions (see Tables 1 and 2) showed an uneven distribution for both. This merely reflects that some

offences are more common than others[3]. In fact, of the eleven possible offence types for both precursor and index offences, four categories were responsible for approximately seventy-five and ninety-eight percent of their respective distributions.

Table 1 – Index Offence Frequency

| Serious offence type | Frequency | Percentage[a] |
|---|---|---|
| Robbery Volume | 162 | 32.9 |
| Sexual Offences | 144 | 29.3 |
| Murder | 108 | 15.7 |
| Robbery Serious | 67 | 13.6 |
| Violence | 11 | 2.2 |
| Total | 492 | 100 |

Note:    a Percentages may not add to 100 due to rounding

The crime types listed in Table 1 have been derived from logical aggregations of similar offences (eg Murder includes Homicide, Manslaughter, Attempted Murder and Accidental Death).  It is apparent that the distribution of incidents is skewed towards a couple of categories.  It is worth pointing out that the observed distribution relates to detected crime, not recorded crime, hence the reason that there were so few violent crimes observed in the data.

Table 2 – Precursor Offence Frequency

| Early offence type | Frequency | Percentage[a] |
|---|---|---|
| Drugs | 115 | 23.4 |
| Theft Act | 105 | 21.3 |
| Other | 89 | 18.1 |
| Violence | 56 | 11.4 |
| Autocrime | 44 | 8.9 |
| Robbery | 30 | 6.1 |
| Burglary | 16 | 3.3 |
| Rape | 13 | 2.6 |
| Damage | 11 | 2.2 |
| Other Sexual Offences | 9 | 1.8 |
| Homicide | 4 | 0.8 |
| Total | 492 | 100 |

Note:    a Percentages may not add to 100 due to rounding

Precursor offences represent a wider range of criminal behaviour than index offences.  Index offences are, by definition, restricted to a subset of all potential criminal activity, whereas precursor crimes are not constrained in a similar way.

The next step involved cross tabulating precursor by index offences.  The results showed a number of low row and column totals and a large number of empty cells.  Given that a fifth of the cells had no observations it was decided

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[3] Goodness of fit tests were performed and the observed distributions were significantly different from the expected uniform distribution ($\chi^2_{(df\,10)}$ = 375.2 (precursor), 585.2 (index); $p<0.001$ for both).

to exclude crime types with low frequencies.  This diminished the sample size
to 356 observations, a loss of about twenty-seven percent of the sample.

Table 3 – Cross tabulation of precursor and index offences

|  |  | Precursor offence | | | | |
|---|---|---|---|---|---|---|
|  |  | Drugs | Theft Act | Other | Violence | Total |
| Index offence | Robbery Volume | 33 | 39 | 26 | 15 | 113 |
|  | Sexual Offences | 26 | 27 | 31 | 19 | 103 |
|  | Murder | 38 [a] | 16 [b] | 24 | 10 | 88 |
|  | Robbery Serious | 16 | 20 | 6 [b] | 10 | 52 |
|  | Total | 113 | 102 | 87 | 54 | 356 |

*Notes:*  a   *the observed frequency is statistically significantly greater than expected*
*(p<0.01)*

b   *the observed frequency is statistically significantly less than expected (p<0.05)*

The first point to make requires no statistical analysis. Looking at Table 3 it is
clear that the bulk of precursor events (60%) were for drug and theft offences.
If one includes the data omitted from Table 3, the figure is forty-five percent.
This dramatically illustrates the point about offender versatility. It means that
the bulk of DNA evidence used to detect serious violent and sexual offenders
will come from matches taken following theft or drugs offences. Including the
'other' category boosts the figure to eighty-four percent in Table 3 and sixty-
three percent including all cases. More dramatically, the proportion of cases
where the precursor event was the same as index offence (ie offender
specialisation) was six percent.

This does not mean that no specialisation is evident in the data. To know this
one would need to know the sampling fraction for taking DNA samples for
each precursor event type. However it does mean that the absolute majority of
DNA evidence in serious cases as defined here results from taking swabs from
the perpetrators of other offence types. In our view it strongly supports the
case for taking criminal justice samples as widely as possible.

Table 3 shows the general picture linking precursor and index offences. It
allows us to go further and look at particular individual associations evident in
individual cells. Overall there was a relationship between precursor and index
offences ($\chi^2$=19.6 (d.f.=9)).  Examining differences between the observed
counts and that expected (calculating adjusted residuals (Agresti and Finlay,
1997)) showed that this relationship was generated by only three cells, or
offence combinations.  These are described below.

### Drug arrestees who murder

Arrestees for precursor drug offences have more murders among index
offences than expected.  They account for over forty percent of the index
murders. What type of drugs offences (possession or supply) or murders
(drug-related, gang-related, intimates) these represent is unknown. Further
research on the topic would be valuable.

### Thieves who (don't) murder

Table 1 suggests that individuals with precursor theft offences are less likely to go on to commit murder. Perhaps unsurprisingly, individuals arrested for precursor theft were most likely to commit index robbery (volume) and serious robberies in a non-trivial proportion (20%) of cases. For both offence types the adjusted residuals were significant (positively) at the ten percent level.

### Other offenders who commit serious robberies

The category 'other' is used to describe a range of miscellaneous offences. There were (statistically) fewer serious robbery offences among this group than would be expected by chance.

### Violent offenders offend as expected

Future offending patterns of violent offenders tended to show no pattern beyond that expected by the marginal distribution. The observed distribution conformed largely to the overall distribution as shown in the total column. It was anticipated that there would be some relationship between precursor samples of this group and serious index offences, but the adjusted residuals displayed conventional variation. As noted above, to make firmer statements about specialisation on this basis is premature, since we do not know the sampling fractions.

### Sensitivity analysis

In order to determine if the above patterns are linked in some way, a sensitivity analysis was performed (for details see the Technical Note at the end of the paper).

The first cell selected was the drugs-murder combination. By controlling for the high frequency of drugs-murder, the low frequency for theft-murder combination ceases to be statistically significantly different from expectation. In addition, the theft-robbery (volume) and theft-robbery (serious) cells with significance at the ten percent level also diminish such that only the latter retains significance, and that barely.

Examining the impact of changing the theft-murder count to the expected produced similar effects, but the drugs-murder count was still statistically significantly higher (3.10 to 2.29 standard deviations). This implies that the number of drugs-murder combinations may 'produce' the low theft-murder frequency. It appears that this relationship is a stable feature of the relationship between precursor and index offences, over and above manipulations over other offence combinations. Other apparent links between precursor and index offences depend on the drugs-murder combination.

## Discussion

The analysis presented here shows first and foremost that the offence versatility found in other criminal career research is reflected here. The central and in our view important finding is that taking criminal justice

samples from theft and drug offence arrestees has a higher payoff in absolute terms in providing evidence in later cases of serious violent and sexual offences than does taking them from earlier offences of violence. This does not mean that the per case benefit is greater, simply that at the levels at which samples are currently taken by offence type, more later evidentiary benefit is gained from prior theft, drug and other offences than from prior violent or sexual offences. The implication of the study is believed to be that opportunities to take criminal justice samples in less serious cases should never be foregone, since they provide the bulk of DNA evidence in later serious offences. The deterrent effect of the buccal swab should also not be understated, and its extent should be quantitatively researched.

A secondary finding of the study speaks to the more specific links between detected crime types. These observations are not of profound relevance in their own right. What makes them notable is that they offer an insight as to how unsolved crimes may be tackled through efforts in detecting other crime types. Criminal justice sampling facilitates crime detection in a proactive sense by providing the immediate ability to test crime scene sample against a database of known individuals. There was a relationship between individuals arrested for drug offences and murderers and this was greater than we would expect by chance. This offence combination appeared to explain virtually all of dependence observed between precursor and index offences. Once the drug-murder effect was accounted the other relationships appeared to diminish. The interesting aspect of the drug-murder observation is that it is the only volume crime category not associated with a detection rate (conceptually it is, but not for operational purposes), but we argue it reflects police attention. A number of explanations present themselves. At this point we cannot rule out the possibility that these murders are drug related, which would explain the skewed observed distribution. If this is not the case, we speculatively suggest that some police officers may possess a heuristic template of future offending which leads them to ensure a criminal justice sample is taken in cases where the offender is felt to present future danger. Until further work is undertaken, the matter remains unclear.

The major qualifier for these results is that the data used for this work only considers relatively short career lengths (three years at most). This is actually a considerable weakness in the sample. It is highly likely that the individuals with serious offence detections are those who have long career lengths. The most versatile, prolific and serious offenders are most likely to have been excluded from our sample through selecting such a small career length. This could easily be circumvented by expanding the search criteria in a more in depth study. If this comment is well-founded, it may suggest that the central finding, of the relevance of less serious precursors to more serious later offences and the consequence of maximising DNA capture in the solution of serious crime, is conservatively stated here.

Despite the weaknesses and uncertainties surround the data, the results indicate some promising directions for operational policing. They encourage police to take criminal justice sampling seriously and point to the wider benefits of increasing detection rates for volume crime. More certainty of the impacts of volume crime detections could be gained by taking a more

longitudinal approach and considering a more representative sample. A research programme to develop the approach mooted here could offer substantial benefits in understanding and practice.

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*Technical Note: Sensitivity Analysis on a Contingency Table*
The procedure used here involves selecting cells with high adjusted residuals and reducing its influence on the aggregate chi square statistic. As the magnitude of a residual in one cell can influence the values in other cells (consider a two by two contingency table), the replacement of observed values with expected values may impact other cells. This way you can infer whether positive residuals have been generated by the presence of negative residuals and vice versa.

The calculation of residual scores is based on the marginal row and column distributions. This has the effect of making each cell's contribution relative to each other cell in that row and column. For instance, if a cell in the top leftmost corner has a larger than average frequency (a high positive residual) then, all other things being equal, the frequencies of cells in the top row and leftmost column will be lower than average (and therefore have low residuals).

We cannot be certain of the relationship between high and low residual cell combinations in the data present in Table 3 without further investigation. It could be that they exist in adjacent cells by some process that generated the observed distribution (ie it is a real relationship) or it could be that the high frequency has 'dwarfed' the surrounding cells into appearing low. Equally, high frequencies may only be high due to their proximity to low frequency cells.

In order to discriminate between the cause of a cell's observed frequency and the effect of proximate cell frequencies the following procedure was carried out. A cell is selected according to the size of its residual. The observed frequency is altered so that its contribution to the chi square is effectively zero. The convention used here is to replace the observed frequency with the expected frequency in the first instance. This will impact the expected distribution and therefore the chi square scores and the adjusted residuals. Further iterations may be required to reduce that cell's contribution to the overall chi square. These changes reduce the degrees of freedom by one for every cell altered.

Once a cell of interest has been modified to an acceptable level, an examination of the resulting residual structure is carried out. The cell of interest should have an adjusted residual between -2 and +2. Other cells that retain high residuals despite the changes in the residual distribution can be considered significant over and above the influence of the cell of interest. Cells with diminished residuals after adjustment indicate some association with the cell of interest.

It is good practice to repeat the exercise, starting with the unmodified observed distribution on each occasion, for each cell with an adjusted residual greater than absolute two.