About us: The Jill Dando Institute is the first university institute in the world devoted to reducing crime and other risks to personal and national security through crime science. Crime science is the application of scientific methods and knowledge from many disciplines to the development of practical and ethical ways to reduce crime. Crime Science research is very applied in nature and we work directly with the police and other law enforcement agencies. The three authors of this report (Professor Kate Bowers, Professor Shane Johnson and Dr Toby Davies) have expertise in crime analysis, data science, crime policy evaluation and policing. We are submitting this evidence as we have direct experience of the use of algorithms in policing.

Summary points and recommendations

We argue that in many situations where algorithmic methods are used to inform policy decisions, an underlying theoretical model should inform the approach taken and that this should be made explicit.

Theoretically informed algorithmic methods applied to social interventions have the benefit that:

- They can provide those competent to act with an understanding of the problem the policy was designed to address. In turn, this can inform operational decision making and what might be implemented in response to algorithm outputs.
- The theory can assist in the identification of indicators of change that might be collected to assess whether responses implemented achieve their ultimate outcomes.
- They can assist in monitoring interventions by assessing whether anticipated intermediate outcomes (effects expected in the middle of a chain of events before the ultimate outcome) have been achieved.
- The theoretical foundation can help to provide legitimacy to the approach taken within the practitioner community.
- Theory-driven approaches can be adapted to take account of substantive changes and hence can be more robust to real world change; those which are agnostic to the underlying mechanism may be undermined.
- Theory can assist with output plausibility and inform what predicted patterns might reasonably look like and – where they depart from expectation - help identify data or processing problems that might otherwise go undetected.

We additionally argue that in the case of social policy, algorithmic methods should not be developed without due consideration of the context in which their application is intended. Output should be sensitive to the level of resourcing available and the practicalities of the suggested activity.

We provide examples of all these arguments in a predictive policing context and explain how the experience we have had would advocate a theory- and practice-informed use of algorithmic methods that is rooted in an understanding of the dynamics of the system and the needs of users.
Use of Algorithms in Predictive Policing

1. Algorithmic approaches offer numerous benefits. For example, they are unbiased by human decision making and the fallibilities of human cognition. However, we would argue that in many situations where algorithmic methods are used to inform policy decisions, an underlying theoretical model should inform the approach taken and that this should be made explicit. In the context of crime reduction, there are a number of benefits to doing this. First, the theory can provide those competent to act with an understanding of the problem the policy was designed to address and the logic of the algorithm. In turn, this can inform operational decision making and what might be implemented in response to algorithm outputs. A theoretical model will articulate the mechanisms through which a problem might manifest and, therefore, provides a basis for the identification of preventative measures. This can also assist in the identification of indicators of change that might be collected to assess whether responses implemented not only achieve their ultimate outcomes (addressing the problem of interest) but whether they lead to the realisation of any intermediate outcomes that are necessary to affect change. Models which lack this transparent theoretical grounding are unlikely to provide such insight.

2. As an example of a theoretically informed approach, we discuss predictive policing, at least as we understand it. We have been conducting research which informs this topic since 2000. This early research was inspired by research concerned with repeat victimisation (for a review, see Pease, 1998) - which showed that recent victims of crime are temporarily more at risk of crime than non-victims - and the theories that were developed to explain this regularity. Two explanations had been proposed. According to the first, known as the 'boost' explanation, repeat victimisation (of the same home, person or place) is the work of a returning offender, who will return shortly after a successful offence as a result of the knowledge they acquire concerning the likely risks and rewards of committing a repeat offence. The second is the 'flag' account, which proposes that certain victims simply represent good targets whose vulnerability can be perceived and exploited by many offenders, resulting in recurring victimisation. Empirical evidence points to a combination of both accounts but, importantly, analyses typically suggest that at least some contribution from the boost mechanism is necessary to explain real-world victimisation patterns.

3. Inspired by these findings and their explanation, in 2000 we explored the plausibility of a more general form of boost whereby the risk of (repeat) victimization would temporarily 'spread' to nearby locations - 'near repeat' victimisation. Our early work focused on the crime of residential burglary (e.g. Johnson and Bowers, 2004; Bowers et al 2004), but has since been extended to a variety of offence types. The initial idea was that, if offenders return to previous targets because of what they learn during an offending episode, they would also be likely to notice and exploit targets in the near vicinity of the original crime location, since knowledge would be acquired about those targets too. The pattern we expected to find was also informed by animal foraging strategies which evolve due to their efficiency. Since 2000, we have found empirical evidence of near repeat victimization for a variety of crime types in various locations around the world. In contrast to the work on repeat victimisation, a substantial benefit of these findings is that they offer predictive value for understanding the likely future risk to those that have not yet been victimised. Simply put, the research suggested that, following an offence at one location, the risk at that location and those nearby would be (temporarily) elevated in the near future.
4. These findings, and the theory that motivated the search for them, informed the development of an approach to predicting where crime would be likely to occur in the near future. To our knowledge, the method that evolved represented one of the earliest crime prediction mapping systems developed. It employed a simple algorithm which modelled how the risk of crime was predicted to spread in space and time, using only historic incident data as input. Evaluation of the predictive accuracy of the approach for the crime of burglary suggested it offered a modest but significant improvement over existing approaches available at the time. Clearly such an algorithm has substantial potential for use in policing, since the identification of likely crime locations can be used as a basis for the focusing of crime prevention effort. The most natural example of this is the direction of visible patrol activity, under the assumption that this may act to deter or interrupt the anticipated crimes. We explored the use of this approach in operational context (see Johnson et al., 2006) with funding from the Home Office.

5. In the period that followed and to date, a number of commercial products have been developed that employ algorithmic approaches to predict future crime locations. Many are based on the ideas described above and are capable of identifying small areas (usually grid squares) that might be prioritised by the police or others. However, what they often fail to do is to explain why certain areas are most at risk, or what might be done in the areas that are identified. Clearly, knowing when and where a problem is most likely is only one part of the puzzle. Knowing what to do is another.

6. With respect to the policing of high risk locations, or what are known as ‘hotspots’, more generally, research has shown that this is more effective when a problem-solving approach is taken. This refers to a process in which analyses are conducted to understand what is driving a crime problem and hence what might address it (Braga et al., 2012). A risk associated with the use of mathematical algorithms, particularly those for which there is no theoretical basis, is that they will fail short of providing such understanding, and therefore fail to provide insight into how the outputs might most effectively be acted upon. In the case of predictive policing as we define it, we recommend strategies that focus on the mechanism through which risk is believed to spread; that is, offender awareness of common vulnerabilities associated with nearby targets. In this case, it is important that these weaknesses are identified and addressed.

7. The theoretical foundation for an algorithm can also be a significant factor in establishing the legitimacy of a system among those required to implement it. Predictive policing is an approach which relies crucially on the compliance and ‘buy-in’ of officers, since they will ultimately be required to carry out the prescribed patrols. The introduction of algorithmic support systems can be met with scepticism amongst officers, and previous examples have been undermined by ‘implementation failure’; that is, a failure to apply the required level of policing response in a timely manner. Convincing officers of the value of algorithmic approaches may be challenging, and this will be exacerbated if the basis for a system is not clear; the case will be much easier to make if the rationale for a system is clearly expressed.

8. A theoretical focus also gives direction as to the expected outcome of interventions and how to evaluate them to identify those strategies that work effectively. Police operations are still seldom evaluated with adequate levels of ‘experimental’ validity. Instead, impact is often measured at the area level by comparing the count of crime before an intervention with that after it. This often leaves little certainty about what effect an intervention might actually have.
had, if any. However, if an intervention is explicitly motivated by a particular set of principles (e.g. the reduction of near repeat victimisation), then more nuanced ‘effect signatures’ can be identified to improve an evaluation. In the case of near repeat victimization strategies, we would expect not just a general reduction in crime, but also a specific disruption to spatio-temporal patterns of crime. If a predictive intervention were to reduce overall crime but not affect the extent of near-repeat offending, for example, this would raise substantial questions about causality. Absent a reliable evidence base, we risk rolling out approaches that do not work or implementing interventions without understanding what the active ingredients of them are, and hence how to improve their efficiency.

9. A further issue concerns the robustness of algorithms to material changes in the systems they seek to predict. In the case of crime, exogenous factors can fundamentally alter the characteristics of offending patterns: the arrest of a prolific offender might remove a significant source of crime, for example, or the installation of security measures on a particular housing estate might reduce the risk of repeat offending. If an algorithm has been developed, or trained, prior to such a change, then it may no longer be valid, and its outputs may no longer be meaningful in the context in which it is applied. This highlights a general risk with ‘black box’ approaches; whereas theory-driven approaches can be adapted to take account of substantive changes, those which are agnostic to the underlying mechanism may be undermined. A similar concern applies to the translation of algorithms across settings (e.g. from one country to another); what works in one place may not in another.

10. The plausibility of findings generated from algorithms also require consideration. Police data are not perfect. For a variety of reasons inaccuracies exist which, if not properly understood, may lead to inaccurate forecasts that appear to be reliable. This can be particularly problematic for “black box” exercises that are not theory-informed. Theory can inform what predicted patterns might reasonably look like and – where they depart from expectation - help identify data or processing problems that might otherwise go undetected.

11. A final point relates not to the theory that describes the problem to be addressed, but to the practicalities of responding to predictions produced. A failure to understand these practicalities can lead to a system that produces highly accurate predictions that are effectively unusable. We explored these issues in our early Home Office report on predictive policing. For example, predictive policing systems might highlight a series of locations that are not necessarily contiguous or even near to each other. In such cases, the policing of these areas might be quite inefficient as officers may spend more time travelling to and from them than they do policing them.

12. A similar concern relates to the areas identified. Existing systems identify high risk ‘boxes’. These boxes can vary in size but do not represent meaningful areas, nor do they reflect the urban layout they overlay. For example, a box may contain one, or a series of road fragments. Some of the roads may be connected, others may not. As such, the boxes do not provide intuitive police patrol plans, and a single box may include a series of roads that will actually have little or no risk.

13. In our early work, we used grid cells for reasons of computational convenience. Others have taken the same approach. More recently, we have been working on predictive mapping
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approaches for street networks (Rosser et al 2016). This is to be preferred for at least two reasons. First, police officers navigate areas along streets and not around or within the arbitrary edges of grid squares. Thus, predictions produced for the street network are likely to be more compatible with the reality of police patrol activity than those produced for arbitrary grid squares. Second, street networks better describe the urban backcloth along which offenders move and hence how the risk of crime is likely to spread. These justifications for the use of networks arise out of an understanding of the processes by which crime risk spreads and the operational realities of policing. Theory is important. And it should complement the benefits that algorithmic approaches provide.

14. To summarise, in a predictive policing context, the experience we have had would advocate a theory- and practice-informed use of algorithmic methods that is rooted in an understanding of the dynamics of the system and the needs of users.

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References


