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Conflicts and congruencies between predictive policing and the patrol officer's craft

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ABSTRACT

In what ways does the introduction of micro-grid crime prediction technology conflict with or align with patrolling officers' craft? We investigate this question using qualitative data collected during a randomised experiment carried out in a large urban police department in the U.S. The current investigation responds to earlier scholars lamenting the 'meaning gap' in works examining police technology adoption. Researchers rode along with officers in two of the treatment conditions, assignment of marked patrol cars to the predicted grids, and assignment of unmarked patrol cars to the grids. This involved keeping notes, observing, and speaking with officers and supervisors about the experiment. Limitations of the technology, including spatial, temporal, and spatiotemporal inaccuracies and/or unresponsiveness conflicted with officers' craft-based knowledge. Concerns about the technology marginalising their expertise and interfering with peer-based responsiveness norms surfaced as well. These reported concerns could reflect conflicts generated by the technology between the bureaucratic, normative, and safety orders within police subcultures. Notwithstanding those concerns, some officers pointed out how the prediction technology helped deepen their craft-based knowledge. Future implementations of such technologies, even on a provisional basis, might benefit from a planning process involving an array of internal stakeholders.

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Introduction

Predictive policing appeared in the lexicon of American policing in 2009 and 2010, when the National Institute of Justice invited researchers and practitioners to explore its concepts, applications, and potential impacts at two symposia. Since then, police departments have adopted predictive policing technologies and strategies with varying degrees of success. Notwithstanding its growing popularity, research on predictive policing is still relatively scarce despite the 'rich set of research opportunities to follow the genesis of what could be a major IT [information technology] innovation' (Mastrofski and Willis 2010, p. 93).

While Perry *et al*. (2013, p. 1) define predictive policing broadly as ' … the application of analytical techniques—primarily quantitative techniques—to identify likely targets for police intervention and prevent crime or solve past crimes by making statistical predictions', the current article examines its application to policing of places. In this geographic context, predictive policing involves using

> historical data to create a spatiotemporal forecast of areas of criminality or crime hot spots that will be the basis for police resource allocation decisions with the expectation that having officers at the proposed place and time will deter or detect criminal activity (Ratcliffe 2014, p. 4).

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It requires, therefore, not only a geographic forecast of likely crime hot spots, but also an appropriate policing response at those locations.

At this intersection of data-driven, technology-assisted policing, adopting computer algorithms is complicated by police cultures that often emphasise traditional patrol and response functions. Such cultural frames, which of course can vary across organisations, districts, and personnel, shape what personnel think technology can and cannot do in policing. In the traditional view it can improve patrol efficiencies but it cannot help with broader organisational outcomes such as crime control (Openshaw *et al*. 1990, Chan 2001, Colvin and Goh 2005, Lum *et al*. 2017). Underlying a cultural frame that tilts toward the traditional on this question is a deeper dilemma, one probably more disturbing to the patrolling officers using these new technologies. Is the technology supplementing and enhancing traditional police skills, acquired painstakingly over years and decades of experience and close observation? Or, is it supplanting areas of expertise? Does it intrude on officers' areas of 'craft'? At a more personal level, the officer may be asking: Is the computer helping me do my job better? Or is it taking over parts of my job wholesale?

These questions arise in an organisational context and a cultural context with complexities: police departments. Thacher (2001, p. 399) argues that police organisations are 'plagued by value pluralism.' Officers 'working amidst value pluralism' are engaged in 'problem setting – figuring out which values are important in a situation and deciding how to evaluate different courses of action' as well as problem solving (Thacher 2001, p. 398). The implementation of the technology described here may deepen involved officers' difficulties in 'figuring out which values are important.' More specifically, turning to the subcultural normative orders highlighted by Herbert (1998), the technology may deepen potential conflicts between specific normative orders or threads within a department's subculture. Three of the normative orders Herbert (1998) highlighted seem most likely to clash in such a situation. (1) The bureaucratic control order 'determine[s] the type and location of incidents for which officers will assume responsibility' (p. 354). The predictive technology, as will be seen, redefines these responsibilities for participating officers. (2) The safety normative order 'encourage [s]' officers to act in ways that 'ensure the preservation of their own life and the lives of others' (p. 357). As will be seen, the predictive technology in the minds of some officers interfered with providing potentially crucial assistance to other officers. (3) The competence normative order 'provide[s] officers with a sense of what constitutes doing a good job, what outcomes will provide them with approbation from their peers. Competence also consists of ensuring that officers pull their own weight,' not requiring 'unnecessary assistance from others in managing their basic workload' (p. 358). As will be seen, some officers assigned to the predictive patrols seemed sensitive to potential criticisms from other officers on the shift for failing to manage their share of incoming calls, 'their basic workload.'

Turning to the technology itself, the specific technological innovation of interest here is algorithm-driven, micro-grid, short-term crime predictions. Technologies like these (such as PredPol), are increasingly used in the US, the UK, and elsewhere (Rummens *et al*. 2017). Yet, as far as we are aware, no large-scale studies have examined how officers, armed with the results of these algorithm-based, short term predictions, respond to the innovation while working with it. Numerous other researchers (e.g. Willis *et al*. 2007) have described how innovations like Compstat reflected and shaped organisational dynamics, describing more macro-level dynamics than those examined here. The purpose of this paper is to describe and organise these responses, specifically as they bear on questions of police work as craft *as seen from the perspectives of the involved officers*. These responses will highlight the implementation and adoption challenges facing predictive policing at the patrol officer level, and how these challenges arise from, sometimes reinforce and sometimes challenge aspects of police culture which emphasise patrol work as a craft.

Other researchers (e.g. White *et al*. 2018) have attended to the perspective of line personnel, for example describing involved officers' reactions to technological innovations like body-worn cameras (BWC). BWCs, of course, are a different type of technological innovation than the one discussed here. That aside, the Tempe (AZ) implementation of BWC revealed substantial officer-level concerns about

the technology, even at the final wave of survey assessment (White *et al*. 2018: Table 1). When asked about the BWCs at the final survey wave, 46.8 percent of officers agreed/strongly agreed 'Officers will feel like they have less discretion', and 59.7 percent agreed/strongly agreed 'Officers will be more cautious in making decisions.' In short, sizable fractions of officers persistently surfaced concern. Albeit focused on a very different type of technological innovation, the current qualitative investigation allows us to dig more deeply than closed ended surveys would; we might learn more about the thinking of officers who see potential downsides to a technological innovation.

This paper is structured as follows. The next section reviews relevant innovation and policing literature. A brief summary of the design of the Philadelphia Predictive Policing Experiment follows. Additional contextualising explains how patrol officers in the department responded in the light of previous experiments. The qualitative methodology is explained. Then aspects of the key themes that emerged and are specifically related to the interplay between predictive policing technology from the patrolling perspective, and patrol work as craft, are described. A closing section comments on challenges of integrating these technologies, places these challenges in the broader scholarly context examining police normative subcultures, offers suggestions on implementation protocols, and considers limitations of the current work.

A tentative introduction of predictive technology to the policing craft

The policing craft (Willis and Mastrofski 2018, p. 1) represents 'the knowledge, skill, and judgment patrol officers acquire through their daily experiences.' It is what experienced officers know about who will be where and when, how people will react under different circumstances, and how what the officer does is likely to affect the behaviour of potential offenders. In essence, the craft consists in part of experience-based judgments under uncertainty, judgments which have their own built-in short-cuts (heuristics), advantages, and disadvantages (Tversky and Kahneman 1974, Willis 2013). Relying on these subjective assessments might lead to police officers preferring their own judgment rather than outside data when it comes to deciding where to proactively patrol (Koper *et al*. 2015, Brayne 2017, Lum *et al*. 2017). Such judgments might use 'prior probabilities correctly when they had no other information' (Tversky and Kahneman 1974, p. 1125). For example, one LAPD captain recounted to Brayne (2017, p. 14) a typical refrain from patrol officers: 'You know what, I know where the crime's occurring. … Okay, so [at intersection], I know there are crimes, I could have told you that. I've been working here 10 years! There's always crime there.' This example highlights how officers' judgments derive from and receive justification from extensive in-the-field experiences.

It is not unusual for the commitment to this field-built, experientially-based type of knowledge in a police culture to dominate how officers and departments approach crime reduction. If the commitment does dominate, it can be an obstacle to the implementation of innovative policies and practices within a department (Bayley and Bittner 1984, Willis 2013, Willis and Mastrofski 2014). Formal, scientific forms of knowledge might be dismissed by patrolling officers as invalid, irrelevant to their daily duties, or potentially harmful to their decision-making processes (Thacher 2008) *because* they are not grounded in the collective wisdom of experienced patrol officers. Given that disconnect, officers might see these algorithms as 'incompetent, irrelevant, and immaterial' as district attorney Hamilton Burger so often objected to Perry Mason's courtroom questions decades ago.

The sources of discomfort and hesitation are several. Most simply, the knowledge base of the technologies overlooks patrolling officers' judgments and instead uses as its foundation data and algorithms officers cannot see. So, the craft-linked judgments and predictions get overlooked, and reliance is placed instead on something as mysterious as dark matter. It is, for the patrolling officers, literally a black box technology.

Of course, the foundational differences between a craft-based and technology-driven approach are enormous. Scientists building the algorithms will emphasise generalisable principles to guide decision-making processes. The algorithms are built on nomothetic regularities. By design, such an approach does not incorporate the highly situational nature of experienced officers' judgments. In

contrast, those involved in craft professions (like police) understand and value the relevance of contingencies and adaptability (Willis and Mastrofski 2014). This is an idiographic approach to understanding. It is the intricacies and contingencies of police-citizen interaction that dominate front-line patrol work (Thacher 2008, Mastrofski and Willis 2010, Willis 2013).

From this perspective, the nomothetic approach of the predictions might seem unduly broad or insufficiently textured to officers. [1] An algorithm might look at street corners in a neighbourhood with all-night take-outs and bus stops within 400 feet as similar, while the officer with experience in a locale will know details about who waits for which bus at which times and how those variations make corners that look comparable to an algorithm noticeably different places when seen close up. The algorithm ignores what experienced officers know, and substitutes a generalised and therefore sub-optimal or deficient –from the situationally-oriented experienced officers' views—black box approach to crime prediction. It is no wonder some officers suspect the real agenda is to replace their decisions about where to go and when with decisions made by the algorithm itself. That is, to completely moot everything the officer knows and uses when making patrolling decisions.

Of course, leaders in the field and in specific departments can move away from the experience vs. technology zero sum game worries of patrol officers by framing the technologies as officer decision-making aids. In this view, the technologies that are most effective either augment officers' decision-making or provide additional data to better inform the officers' decision-making process (Flanagin 2002). Officers' judgments and decisions are still the hub for all patrolling decisions. Given this view on the officer/technology interface, it is not surprising that patrolling officers accept technologies more readily if those technologies provide high quality information in a timely manner (Colvin and Goh 2005). In this view, the technologies, as decision making aids, should generate measurable improvements in policing effectiveness and efficiency (Groff and McEwen 2008).

Innovation adoption, implementation failure, and cultural barriers

Understanding whether and how patrolling officers adopt predictive policing technologies can be viewed as a process of introducing an innovation to an organisation and understanding the challenges to implementing and diffusing the innovation in and through the organisation. The innovation can fail for any number of reasons, but two broad classes of factors include *technology failure* (the innovation just does not work) and *implementation failure* (the innovation was not adequately operationalised within the organisation). An innovation is defined as; ' … a product or practice that is new to its developers and/or to its potential users' (Klein and Knight 2005, p. 243). Innovation failure often is caused by implementation failure (Pressman and Wildavsky 1984). Nevertheless, innovation implementation can be neglected within innovation research (Klein *et al*. 2001, Klein and Knight 2005), especially when innovations are introduced in field experiments focused on 'hard' results, what Thacher (2001) calls the 'medical model' of policing treatments. Of course, this may be changing more recently with field experiments of innovations giving careful consideration to implementation (White *et al*. 2018).

Of course, police departments in the US and around the world have implemented and benefited from adopting numerous new tools and techniques over the last century-plus: call boxes, patrol cars, radios in cars, 911 call dispatch, MDT systems in cars, and computerized mapping technology to name just a few (Manning 2003). But these innovations notwithstanding, patrol technologies remain largely unchanged since the 1930s; the core patrolling functions and tools have not been replaced by technological innovation (Mastrofski *et al*. 2009, Manning 2003, Mastrofski and Willis 2010). 'American police are simply too invested in the structures and practices of the standard patrol technology, even if the scientific community considers it ineffective' (Mastrofski and Willis 2010, p. 83). This investment is a key underpinning in the cultural frame emphasising traditional approaches to patrol.

That investment and reliance on traditional patrol and policing strategies has driven and continues to drive what metrics departments select to benchmark success: clearance rates, response

times, and arrests. But a focus on these metrics carries hidden costs. Such narrow metrics can miss whether departments are working intelligently with empirically proven methods (Sparrow 2015). In addition, these performance measures, emerging from traditional policing and patrol methods and technology, further reinforce the centrality of these actions and tools. Consequently, this '… keep[s] the new, alternative technologies at the periphery of the organisation's service delivery system' (Mastrofski and Willis 2010, p. 84). Finally, a focus on such metrics can mask the value pluralism (Thacher 2001) operationalised on a daily basis by patrolling officers as they seek to accommodate a range of goals in different encounters.

Some might argue that this mutually reinforcing link between traditional methods and technologies for patrol, and success metrics, has been weakened of late. Over the last 30 years numerous patrol-relevant policing innovations have proven their effectiveness: new police practices such as problem-oriented, hot spot, and intelligence-led policing have proven effective in reducing crime and been widely adopted across U.S. police agencies (Mastrofski *et al*. 2009, Braga *et al*. 2014, Carter 2016).

Specifically related to predictive policing, crime mapping data and technology have been used by police for more than two decades (Weisburd and McEwen 1998, Ratcliffe 2000, La Vigne and Groff 2001). Crime mapping aids in the Compstat incarnation seek to understand crime that has already happened, and to encourage patrolling officers and their supervisors to learn more about past patterns so such patterns can be interrupted in future. The data generated are about what has already happened.

By contrast, the more recently introduced sophisticated algorithms are for crime *prediction* rather than description or explanation of what already has happened. This represents something new and different (Johnson *et al*. 2009, Mohler *et al*. 2015, Taylor *et al*. 2015).

Some scholars fold micro-level crime prediction algorithms into a broader suite of risk prediction applications supporting a broader class of activities referred to as 'technologically mediated surveillance' (Brayne 2017, p. 4). But from the craft vantage of patrolling officers, it may be this shift to prediction that makes these technologies different. By linking crime mapping and hot spots policing geo-technologies to *predictive* policing (Weisburd and Majmundar 2018), these technologies set up a direct challenge to experienced officers' judgments and heuristics (Tversky and Kahneman 1974). In short, perhaps for the first time, the predictive policing technologies directly challenge the craft knowledge base guiding patrolling officers. At best the technologies intrude on and constrain the 'craft' of policing; at worst the technologies dismiss entirely beliefs in and believers in police craft (Manning 2001). The challenge to beliefs set up by introducing predictive technologies could contribute either to implementation failure of the technology, or to slower adoption within an agency, or both. Do officers say anything that might bear on such challenges?

Further, the reactions to predictive technologies can be framed using a subcultural lens. This vantage would suggest a different narrative for implementation failure or slow adoption. As described above, three of the normative orders within Herbert's (1998) subcultural frame could conflict more intensely with the technology introduction. As will be seen, the implementation assigned officers to specific locations (bureaucratic control normative order). The assignments might hinder assigned officers' responsiveness to other officers in need (safety normative order), and/or cripple their contributions to fielding incoming calls, in violation of the competence normative order.

Police scholars examining new technologies in police departments tell us that the issues highlighted above, the interplay between implementing predictive technologies and acquired cultural views on patrolling and police work as craft, have been overlooked in research and evaluation. Although there are notable exceptions (e.g. White *et al*. 2018), police agencies bringing in new technologies rarely assess or evaluate them *as they operate in their specific departments.* Instead, they rely on the idea that the technology works in theory and fail to consider how it might best work in their specific organisations (Willis *et al*. 2007, Weisburd and Neyroud 2011). More broadly, research on innovations in policing often neglects these same issues, focusing instead on the quantitative

outcomes of the innovation itself, whether a reduction of crime and/or disorder results. Consequently, there is a 'meaning gap' (Greene 2014, p. 219); ' … in our zeal to pursue the more 'scientific' aspects of research on the police, we have often settled for statistical results absent contextual meaning; resulting in the pursuit of Durkheim's social facts without the associated social interpretation'.

We contend, as have others (Greene 2014), that it is worth trying to close this meaning gap. We can learn more about the contextual dynamics of police organisations and how they deal with innovation and strategic change (Greene 2014). Further, by using a qualitative approach we can gain more insight into the thinking behind concerns persistently voiced by officers involved in new technologies (White *et al*. 2018). Here, the innovation examined is a predictive policing model implemented during a randomised control experiment in Philadelphia.

Focus

How do patrolling officers and their supervisors react to mandated adoption, on a clearly experimental basis, of a micro-grid predictive policing algorithm? If the introduction of this technology, given its predictive nature, creates a starker contrast with traditional views about basing patrolling decisions on experientially based police judgments, and policing as craft, what kinds of interplay do we see as traditional views encounter a black box technology that seems to discount their experience base? What potential conflicts emerge for officers between different threads of the police normative subculture? What happens in the patrol car where this technology is being used? Can these two types of knowledge—the nomothetic regularities captured in the prediction algorithms and the context and contingency driven idiographic understanding acquired by officers over the years that ground their craft wisdom—learn to get along? What are the implications of this interplay for deepening our understanding of implementation challenges and implementation failures? More broadly, the current investigation responds to earlier scholars lamenting the 'meaning gap' in works examining police technology adoption, works that have focused too much on hard outcomes and too little on context and process.

The Philadelphia predictive policing experiment

The Philadelphia Predictive Policing Experiment was a citywide randomised, controlled, National Institute of Justice funded, field experiment that took place from June 2015 to January 2016. Philadelphia has just over 1.5 million residents, making it the 6th largest city in the U.S. With over 6,300 police officers, the Philadelphia Police Department is the 4th largest in the country, behind Los Angeles, Chicago and New York. Under the leadership of then-Commissioner Charles Ramsey, the department at the time embraced a learning organisation mentality and had previously experimented with various policing styles, including foot patrol (Ratcliffe *et al*. 2011), problem-oriented policing, and an offender-focus approach (Groff *et al*. 2015).

The predictive policing experiment followed these earlier studies and comprised two three-month phases that used predictive policing software to try and reduce crime; a three-month property crime phrase, followed by a violent crime phase. Philadelphia has 21 geographic field districts (not including the international airport) and 20 districts were block randomised to one of four experimental conditions (the lowest crime district was dropped from the study in each phase). In each phase, five districts acted as controls, with a business-as-usual patrol strategy ('control' districts). In five districts, officers were made aware of the predicted high crime activity area at roll call and asked to concentrate patrol in the areas when able ('awareness' districts). Five districts received the awareness model treatment but also dedicated a patrol car to the predicted crime areas ('marked car' districts). Finally, five districts received the awareness model treatment as well as dedicating an unmarked unit to the predicted crime areas ('unmarked car' districts). Officers in marked and unmarked cars were from the local district station, were exempt from answering radio calls outside their areas but were encouraged

to respond to related radio calls (property or violent crime) inside their predicted grid areas. Districts were re-randomised between the property and violent phases.

The predictive policing software used was the HunchLab programme designed by Azavea. Hunchlab is a web-based predictive policing system that accesses real-time police data to produce crime forecasts. It incorporates statistical modelling that considers aoristic temporal analysis (Ratcliffe 2002), seasonality (Block 1984), risk terrain modelling (Kennedy *et al*. 2011), near repeats (Townsley *et al*. 2003), and collective efficacy (Sampson *et al*. 1997). Officers at police district buildings in the marked and unmarked conditions could log in and print out maps for forthcoming 8-hour shifts. Azavea adapted the software at the request of researchers to generate three predicted 500 feet square grids per district per shift. They also included a slight randomisation component to reduce the possibility that the same grid cells were predicted every day.

The software forecasted property crime areas from 8am to 4pm every day across Philadelphia from June 1st to August 29th, 2015. Property crime comprised residential and commercial burglary, motor vehicle theft, and theft from vehicles. After the three month property crime phase, the experiment paused for the visit of Pope Francis and the World Meeting of Families in Philadelphia from 22–27 September. Afterwards, the violent crime phase ran from November 1st, 2015 to January 31st, 2016. Predicted violent crime areas were projected every day from 6pm until 2am of the next day. Violent crime comprised shootings, robberies, aggravated assaults, and homicides. Consequently, the study found some positive results for the effect of marked police cars in property crime predicted grids only. More detailed quantitative results are published elsewhere, and the remainder of this article concentrates on the qualitative findings from the field research.

As noted earlier in this section, the police department had participated in numerous previous major experiments, and anecdotally some mid/senior officers expressed a degree of 'research fatigue'. This, combined with some more open skepticism about the merits of predictive policing algorithms, has led the current authors to characterise the police department's approach as tolerant of the research, but not enthusiastic. This comprised the setting for the study that follows.

Qualitative methodology

During the course of the experiment, eight researchers (graduate research assistants and the principal investigators) worked as field researchers collecting observations during just over 100 8-hour ride-alongs with officers who were assigned to patrol the grid areas in marked and unmarked cars. These field observations were used to assess the implementation of the two vehicle-oriented patrol strategies and observe treatment integrity. The observation shifts were determined via random assignment for both the property crime and violent crime phases of the experiment. The field observations had two elements: structured and systematic detailing of officer patrol behaviour which was noted on a form in 15-minute increments; and the use of open-ended ethnographic field notes. This article concerns itself with the latter.

The fieldwork products provide a non-random sample of perceptions and reactions of department members to the deployment of the predicted grids and the experiment as a whole. Conducting the research in the officers' habitat aligns with the perspective of Creswell (2008, p. 4, emphasis added) whereby 'The process of research involves emerging questions and procedures, *data typically collected in the participant's setting*, data analysis inductively building from particulars to general themes, and the researcher making interpretations of the meaning of the data.'

Researchers were instructed to observe the actions of the officers and discuss topics related to the experiment and the software grid placement. In particular, observers were told to keep some of the following themes in mind during the shift: activity level of police, particular strategies employed during patrol, the level of overall activity in the grid areas, citizen interaction, reaction to the grid locations, reaction to the experiment overall, and any unusual events that took place. Researchers were allowed to explore these themes either through direct questioning of the officers or supervisors encountered on the shift, or simply via the natural course of dialogue about the experiment with the

officers and supervisors. The goal was to illuminate the aforementioned interplay between police work as craft and innovative micro-grid predictive algorithms.

Eight field observers recorded jottings while in the field which were then synthesised upon completion of the ride-along. 101 individual field note entries were completed, 79 entries from the property crime part of the experiment, and the remaining 22 from the violent crime portion. In addition, researchers constructed a final write-up, addressing the main themes, lessons, and take-aways from their ride-alongs. The analysis of the field notes was primarily informed by a variation on Deterding and Waters (2018) flexible coding approach. In the first stage, two researchers independently read through all of the field notes and descriptively coded them in the programme ATLAS.ti. This created a set of initial themes identified by each coder separately. These independently generated themes were refined further by comparing and discussing quotes picked out as examples of each theme. Following this conceptual clarification, themes were consolidated into an initial coding list. That list was applied to a subset of field notes. The first ten documents were coded by each researcher independently to assess and discuss levels of interrater cohesion. The researchers then chose a random set of ten documents and coded each independently. They compared these ten coded documents and made further changes to the coding scheme. These mostly involved minor revisions to codes, clarification of inconsistencies and the merging of some codes. This resulted in a final coding scheme of 14 individual codes.

Each researcher took this set of final revised codes and applied them to the remaining 81 field note documents. Finally, one researcher, the third author, merged the two sets of fully coded documents in ATLAS.ti and explored the main themes and relationships between them. The themes discussed represented some of those that emerged, or specific threads within some themes. The following sections focus just on the theme-linked content pertinent to the focus of this paper: the interplay between the contingency-dependent, experience-based knowledge captured in the craft of policing, and the black box micro-grid prediction software and its outputs.

Findings

On software (in)accuracy and spatial and temporal dynamics

We know that officers' views about an innovative technology will be more positive the more efficient that technology is. One of the most important aspects of technological innovations in policing and their ultimate acceptance by front-line officers is the perceived accuracy of the systems (Colvin and Goh 2005). In the case of the predictive algorithms here, predictive accuracy translates into spatial and temporal accuracy. Officers expressed concerns about both. Whether those expressed concerns reflected sincere wishes that the software would 'do better', or instead simply punched verbal holes in one of the highly touted advantages of the mysterious algorithms, is not completely clear.

Officers criticised the algorithm for temporal inaccuracies going forward (the predictive part), as well as temporal inaccuracies post hoc by failing to make adjustments once crime had occurred. In the second case they expected the grids to adjust given recent crime immediately adjacent to grids.

The officers' frustrations with look-ahead failures were captured in a comment like this one: 'One area had been a grid and then two days later it wasn't and THEN there was a homicide there. This grid wasn't a grid yesterday and there was a robbery last night, and now today it's one' (officer quoted in field note #85). There are two threads here. A grid location was perceived to have been dropped prematurely, and another grid location got added, but too late. In the latter case, the officer recognises that the grid has made an adjustment – in contrast to the two officers' experience immediately below – but he/she laments that it was a post hoc adjustment rather than a predictive adjustment.

The flip side of this look ahead failure is that grids might repeatedly say something will happen in a specific location, and it doesn't. In one district, during the evening shift violent phase of the experiment, two grids assigned were adjoining strips and officers felt that these two grids made more

sense than the third assigned grid off in a relatively quiet corner of the district. These first two were close to major arteries and small, corner commercial activities, as well as some more substantial commercial locations. Yet, both officers were disconcerted by the fact that roughly the same grids in this part of the district showed up night after night (not checked against actual generated grids). 'Three nights in a row, right D?' one officer asked the other, who confirmed. And during that time, no violent crimes had occurred within the grid. In essence they were asking why target this grid night after night if nothing is happening here (field note #96)?

The look ahead temporal failure was further compounded by two additional features: a spatial near-miss failure, and an inability to learn from the recent past. The same two officers reported that a homicide had recently occurred (the observer got a sense it was within the last week), taking place just a block or so outside of the assigned grid at the time. The grid was 'off of homicide by 1 block'. Adding insult to injury, not only did the grids miss the homicide but once that crime had taken place the grid boundaries had not adjusted in the days since. One of the officers said, there is something like a shooting 'but it [the programme] does not put you there the next day.' With this last comment it seems that officers with their craft knowledge were expecting repeat shootings. Retaliatory shootings can and do happen in nearby blocks in the immediate aftermath of an initial incident (Ratcliffe and Rengert 2008, Wyant *et al*. 2012). *And the officers know this.* But the algorithm doesn't necessarily reflect such expectations in the eyes of the officers (field note #96).

Philosophically, prediction is an impossible task

Experienced patrol officers in a major metropolitan department end up over time seeing everything of which human beings are capable. Bizarre, weird, mean, evil, and charitable. They've seen it all. So it is not surprising that they find the idea of a computer algorithm predicting crime as naïve, foolish, misguided, and doomed to fail. Many experienced officers would probably agree with the one who opined 'no computer algorithm can interpret real life' (field note #25). One researcher wrote,

> I would walk into districts and be introduced to supervisors who would ask me 'Do you really think you can predict something using a computer?' That was primarily the largest issue that supervisors—and officers as well—had with this project: they had a very hard time accepting that computer software could be successful (field note #104).

Another officer remarked to a researcher 'There's a man petting a watering can – and you guys think you can predict where the next burglary's gonna happen?' (field note #2).

For officers who hold such views, it's not so much the repeated spatial and/or temporal and/or spatiotemporal inaccuracies that make them distrust the resulting grids. Rather, for them, the task is inherently impossible from the outset, given the complexities of human nature they themselves have witnessed first-hand and repeatedly. So in their view, of course the results will be inaccurate.

Let us into the black box, or let us replace it

The lack of a human element to the software, combined with its inherent black box nature, concerned many officers. But some, rather than rejecting the entire enterprise, advocated for allowing in the human element, opening up the black box so that the experienced officers' knowledge base could contribute. 'You [the researcher] need to come and ask street officers where the boxes [grids] should be, they know where crime is' (officer quoted in field note #1). It is not clear if this one particular officer was asking that the algorithms be opened up to solicit and take into account experienced officers detailed knowledge, or if he/she was proposing an alternate.

Other officers, however, were quite clear on their preferred algorithm–free alternative. When asked about any improvements that could be made to the software, one officer explained; '.... instead of slapping squares on a map and hoping they fucking stick ... Tell them to have real people who have been out in this [indicating the community], not behind a desk all day' (officer

quoted in field note #82). These comments are emblematic of a continuous theme through the experiment, that any software programme was incapable of adding to the accumulated knowledge that officers possessed, and, more implicitly, that the same officers were incensed about such an oversight.

Perhaps officers were particularly upset because the purpose of the software was to predict not to describe what happened. In the Philadelphia Police Department, crime mapping software was generally accepted. A supervisor invited the research team and the software developer to 'come to the … district, you can see our crime maps, to see where crime really happens' (supervisor quoted in field note #18). Both computer systems used the same crime data but perhaps the software behind the district crime maps proved more acceptable because it just simplified a transcription task, generating a product that de facto displayed part of experienced officers' knowledge base, rather than challenging that knowledge base. Perhaps the officers suspected that the predictive technology de facto challenged their commitment to the competence normative order.

OK, perhaps this might help deepen localised knowledge

Although many officers questioned the merits of the technology and the associated patrol strategies, some officers and supervisors expressed support for the project and its possible value to daily operations. They were willing to accept that the predictions could help them deepen their localised knowledge. The perceived potential value could arise from two features. First, this was just something different, and progressive departments should embrace change. The craft side needs to keep up with the changing times. Second, they could see specific ways their traditional work was supported. Officers expressing this theme did not see craft/algorithm conflict, but rather craft advancement through innovation and specific improvements. Along the lines of the first feature a researcher wrote; 'The officer also mentioned how she was supportive of any types of changes in policy trying out new things' (field note #70) and '[The] officer mentioned that he likes the idea of incorporating more technology into policing' (field note #13). Along the lines of the second feature, one officer noted value because

> she liked being in the predictive grids because the grids would occasionally take the officer down streets that she had never patrolled before. This officer has been in the district for quite a few years and she was surprised there were so many streets that she has never patrolled (field note #107).

Here, the officer sees how the algorithm extends her craft by growing her specific knowledge base about the locale. The algorithm has the potential to deepen her commitment to the normative competence order.

Along a related line, certain officers recognised that establishing a presence in grids through repeated patrolling encouraged talking more with locals, which again deepened their detailed understanding. Certain officers were aware of this potential benefit, and pointed this out to one of the researchers; 'The officers felt that the experiment allowed them to establish a presence [through repeated patrolling] within the grids, which allowed them to interact with citizens much more than they typically would' (field note #14). The potential benefit of increased citizen interactions is important for the craft aspect of policing as citizens are often the ones who provide the most helpful information to officers. As one officer pointed out; 'I think it's productive. We're gathering intelligence, we are speaking to people' (officer quoted in field note #50). The 'craft' of policing builds on interactions between officers and citizens; these interactions help officers understand people within the community and establish relationships that may provide useful information in the future (Bayley and Bittner 1984, Willis and Mastrofski 2018). Grid assignments were furthering these goals.

Over the course of the experiment, researchers observed the lengths to which officers would interact with the citizens of the community and the value they placed in these interactions. Many of these interactions were friendly and intended to build better relations between the community and the

police. As one researcher noted; 'Officers consistently interacted with individuals on the street- often saying hi to passersby or even stopping to chat with some individuals. They both stressed the importance of community relations and being cordial with citizens' (field note #56). Another officer stressed,

> It's always great to talk to people, I find. They tell you some important stuff. I have a bunch of people who, yeah they're criminals and they know if I find them doing something illegal, I'm gonna lock them up, but they tell me what I need to know. Like, 'Hey, did you hear about that shooting?' 'No, I didn't, why don't you tell me about it.' And that's how you get some good information. (officer quoted in field note #7).

Interfering with the peer-to-peer norms of the craft

Part of the craft of policing is not only understanding what will happen where when (Herbert's competence normative order), but also internalising obligations to fellow officers (Herbert's safety normative order). The ability to support one's colleagues by taking on an equitable share of the daily workload and responding with alacrity to avert potential officer harm are important elements of police craft and culture.

Some officers were concerned, sometimes even angry, about being unavailable or unable to answer calls for service outside of the areas; they viewed this as antithetical to their deep obligation to support other officers. (Officers in the predictive grids were permitted to backup other officers when assistance was requested, but this was not clearly understood early in the experiment.) One observer noted that 'The officers got more and more angry about the project with each passing call that they weren't allowed to attend. Each additional call would send them into a string of curses about the project and their time being wasted' (field note #82). The geographic restriction of the grid assignment (bureaucratic control normative order) conflicted with carrying their fair share, the competence normative order.

Related to but distinct from perceived constraints on responding to officers who might be in need, was the mere fact of assigning cars to specific locations for crimes that in the minds of most officers probably were not going to happen; this took away needed front-line personnel from the important job of running after serious calls. Bear in mind the department did not receive extra resources for these patrol car allocations. The car allocated to a grid was a car not chasing calls about serious crimes. The volume of these calls is hard to appreciate. To a researcher sitting in the back of a squad car late on a weekend night, the crackle of calls coming over the radio referencing man with a gun, shots fired, man with a knife, a fight, a purse snatch and the like, seems like a relentless torrent. By late in the evening it seems that the calls crackle across the radio immediately one after another. One officer remarked somewhat caustically to a researcher as he climbed into a car, 'Look at all the jobs I have left (10) – So I'm *really* gonna patrol that grid area' (field note #2). It's no surprise given the chronic sense of being overwhelmed then that the diversion of needed and experienced resources for such a seemingly arcane purpose would engender deep resentment. Obviously, this interferes with innovation buy-in (Clayton 1997, Klein *et al*. 2001). One officer stated 'We hate the prediction project. I mean, if we had what we needed (staff and cars) it wouldn't be so bad' (field note #45). One supervisor was struggling to find a car and officers to dedicate to patrolling the predicted grids for the shift, saying to a researcher, 'In the meeting with [a senior officer], they promised us cars and overtime. We still haven't seen any of that' (field note #75).

What counts as real police work?

The above theme broadens out into a distinct but related one. Officers, through experience, know what needs to be done to catch criminals, which is, putting aside for the moment the operative value pluralism (Thacher 2001), the 'real' police work. A criminal does something, and they take care of it. Staying on predicted crime grids in the minds of some directly got in the way of doing what needed to be done. As one supervisor pointed out, 'They are doing this during the time of

year when manpower is already low … If I don't have an officer to respond to a call for a suspicious person … then that potential suspect is never apprehended and questioned' (field note #75). Note the sensitivity to elapsed time in this context. Based on past experiences, this officer judges a quick response as critical to advancing an investigation. This is part of his/her craft-based knowledge. But the officer cannot react to it because he/she is patrolling a place where a crime is supposed to happen.

Ironically, especially in the violent crime phase of the experiment, because so little predicted crime was happening in the prediction grids, a problem related to the size and time span of the grids (Taylor and Ratcliffe 2016), the grid assignments facilitated officers doing a different type of real police work: getting to know people in the grids, gathering intelligence, and responding to small scale order maintenance incidents surfacing on the streets. One observer witnessed the following, for example.

> About a half dozen or more people were waiting at the bus stop, people were going into and out of the store, and people were in the store. C went into the store to sign a security log. A woman was panhandling outside the store, trying to get money for cigarettes. C asked D to record her ID card. He did. D explained that he would do the paperwork for the ped stop form later on when they went back to the station at end of shift. C went back to the woman and explained that she could not panhandle in front of the store, and needed to move along. They chatted for a couple of minutes (field note #96).

Later that same night, well after 9:00 PM in December when streets were quite dark, in the same district but back patrolling the 'quiet' grid that seemed to make no sense to the officers, while rolling down a small side street at slow speed, officers saw:

> several people in street at corner … Turn down. Turns out to be about a half dozen pre-teens, playing in the street. C tells them curfew. They don't respond. Shows his badge. Says again curfew. The littlest one pipes up (10 years old? Less?) "but it's Friday night." C explains it doesn't matter. They have to be inside. Eventually a somewhat older female comes over and it looks like the kids are moving. [Thought. Some could see this as harassment. But on a dark street, playing in the middle of the street, kids obviously have a chance of getting hit. Even more to the point, if this is in a high potential violence location, then there is [a chance of] getting hit by stray gunfire. So there is the public safety aspect. And of course, police doing parenting.] (field note #96).

In short, in predicted micro-grids, where, especially if the crime in question is violent crime, on any given night the chances of a crime actually occurring are almost vanishingly small (Taylor and Ratcliffe 2016), officers assigned to grids might be preventing violence. But, more obviously, they are doing another type of 'real' police work, work that reflects and builds on their craft knowledge foundation. In short, the predictive grid assignments directly interfere with one type of real police work, catching criminals, the type of police work most deeply embedded and central to the officers' craft knowledge; at the same time the assignments directly advance another different but arguably equally real type of police work, another aspect of their craft, getting to know the locale better, interacting with citizens given what they know, and more generally keeping an eye on the streets.

These arguably contradictory views speak to the varying perspectives on a long-standing discussion about what constitutes 'real police work'. On one hand, the predicted grids allowed a focus on the 'real' police work of patrolling for crime, getting to know people in the grids, and gathering intelligence. This is the 'medical model' (Thacher 2001). At the same time, inevitable resource constraints brought this into conflict with the equally 'real' police work of responding to calls for service and shouldering one's share of the workload, and helping colleagues avoid harm.

In short, in the context of an under-resourced big city police department always flooded with calls, the geographic restrictions associated with this type of predictive grid assignment, reflecting the normative bureaucratic control order within police subculture, conflicted directly with the normative competence order of the subculture (Herbert 1998). The conflict proved especially grating given the small size of the grids themselves, and thus the extremely infrequent rate of crimes occurring within them (Taylor and Ratcliffe 2016). The conflict may have been blunted if the mission areas had been larger and thus hosted more crime.

Discussion

The current work has attempted to clarify the conflicts and incongruities between predictive policing algorithms focused on microscale grids, and the contingent, contextual, experiential foundation guiding the craft of police patrol work. On the one hand the predictive algorithms can be seen as just another technological innovation, part of a long line of innovations that have been introduced to police departments over the last century. Given this we would expect specific features of the innovation would shape officers' responses. As Colvin and Goh (2005) have pointed out, innovations that provide high-quality timely information are likely to get a more positive response from experienced officers. And indeed, patrolling officers proved sensitive to such defects. Predictive grids that missed crime temporally or spatially or spatiotemporally, or failed to respond to crimes that had happened, frustrated officers and made them question the wisdom of intensively patrolling such sites. That feature, when combined with another feature of the experiment, the small size of the grids and thus the low frequency with which crimes occurred in the grids, deepened officers' concerns.

But at the same time there was more going on here than just issues of innovation quality, or lack thereof as exemplified by inaccurate predictions or nonresponsive predictions. The technology conflicted directly with the whole notion of police patrolling as a craft in multiple ways. The predictions embodied nomothetic understandings about crime times and places, completely overlooking the detailed, contextual, and contingent knowledge that patrolling officers have acquired about their beats. In effect they were berating this wooden-headed approach when they criticised the predicted grids spatial/temporal crime prediction failures or non-responsiveness to past crimes.

Simultaneously, some officers feared that the black box of the algorithm ultimately sought to replace officer decision-making about patrolling. Further, the prediction technology sometimes placed them in direct conflict with deeply felt obligations that were also part of their craft-based knowledge. Assigned officers resented not being able to respond to calls for service, fearing that fellow officers might not be getting needed assistance quickly in dangerous situations. They knew from experience that some fraction of times the crucial and quick appearance of backup could help another officer avoid serious harm. They also knew from experience the chronic overwhelmed situation which police officers in major cities routinely find themselves in and resented that predictive grid assignments interfered with them shouldering their fair share of the workload.

The above observations can be viewed as illustrating how different features of a police normative subculture can conflict with one another. Three of the orders highlighted by Herbert (1998) seem especially pertinent. Assigned officers vigorously patrolling the grids underscoring their commitment to the normative bureaucratic control order. But because little crime was happening there, the opportunity costs associated with these restrictive patrolling patterns proved salient to assigned officers and created conflicts with other normative orders. They could not respond to garden variety calls, unless they were nearby, putting them in conflict with the normative competence order. Further, many officers felt they could not assist other officers in need, putting them in conflict with the safety normative order.

But such normative conflicts might be diminished if the predicted grids were scaled up geographically so they hosted more crime. We are not aware of any situations where in a predicted grid, on a predicted shift, officers encountered a crime in progress of the type predicted. Such a situation would be extremely improbable, especially during the violent crime phase, given how spatially and temporally limited the grids were (Taylor and Ratcliffe 2016). But even if there was such a predicted 'hit,' would it increase officers' buy-in to the innovation? Or would it be discounted as luck? We don't know. It would be interesting for future research examining the process of implementing these technologies to track how such a hit might or might not alter officers' views over time. Or, alternatively, if predicted grids were larger and hosted more crimes, but not so large that officers could not be on the spot promptly, would that increase officer buy-in because it lessened these conflicts between competing normative orders?

Our suspicion, and it is only that, is that given the deep-seated conflicts between the predictive technology and the painstakingly accumulated knowledge that shapes the craft of police patrol, one or two 'crime-in-progress' hits are unlikely to convert large numbers of officers into innovation boosters. That said, future research could hopefully explore these possibilities. Researchers could pay closer attention to what officers say, and how they describe what they do, especially as it relates to Herbert's (1998) subcultural normative orders.

At the same time, the predicted grid technology supported a different side of the craft of police patrol while it simultaneously interfered with the 'what to do about serious crime' part of the knowledge base. More specifically, and ironically because crimes were so scarce within the grids, officers got to know more about their locales and the locals. Despite having worked in their beat for many years, they travelled down streets and alleys they had never seen before. They had time to take care of relatively minor things happening on the streets. They had time to gather police intelligence about recent crimes from locals. In short, tending to the relatively quiet grids allow the officers to deepen knowledge, deepen contacts, look after minor events, and gather intelligence. All these are also part of the craft of patrolling although not as highly emphasised as the serious crime management side.

This unexpected value some officers found in the grid assignments reflects policing's values pluralism. The not-directly-crime-involved side of the craft got strengthened in the minds of some officers even as other officers chafed at the imposed limitations on chasing down crime and criminals. 'The area of ambiguity that will always remain involves the normative questions of how to think about each of the different values and how to think about the trade-offs among them' (Thacher 2001, p. 409).

Current findings underscore the assertion of Koper *et al*. (2015) that police technologies geared to assist with strategically oriented tasks such as determining patrol locations and when to conduct surveillance between calls for service are viewed more skeptically than other technologies that do not seek to direct core patrolling functions. Our work has advanced their assertion by clarifying some the specifics of the conflicts between this technology and these core functions.

At the same time, the current work takes us further because it also underscores fundamental contradictions in different reactions to the prediction technology. On the one hand officers argued that the software—any software—was not able to perform the function of predicting crime because it basically did not know in detail what was happening on the streets. It is part of the craft of the local beat officer to know his/her patch. Numerous commentators exhorted the researchers to come and ask the local officers, because they knew where the crime could be found. In other words, in this reaction the entire enterprise was fundamentally flawed and will remain so until it started to incorporate what the officers already knew.

But on the other hand, officers, sometimes the same officers, also wanted the software to perform better. Although it was fundamentally flawed, and they had no idea about the knowledge base behind the predictions, they hoped the software could do better.

The contradictions between the predictive algorithm and a related software is stark. Crime mapping software has been available to the department for many years and is an accepted part of the department's processes (Ratcliffe 2010). The Philadelphia Police Department has trained analysts in the districts and at headquarters, and the software is available to officers on the department intranet. At times, officers and supervisors compared the crime maps to the predictive software, even though both were based on the same data sources. Furthermore within the academic community, there is some discussion about whether there is even a meaningful distinction between predictive policing and hot spots policing which can be performed with traditional crime maps (Weisburd and Majmundar 2018). It may be that crime maps are more passive and not tied to the sort of change in work practice that was imposed by the predictive experiment. Or alternatively it may be that crime maps do not make a claim to be predictive, instead merely representing a historical record that allowed the officers and supervisors to apply their own interpretation—preserving the craft of their business. This may explain why some officers and supervisors wanted to have more

input from patrol into the grid choices. In other words, they wanted it to be less actuarial and more clinical, allowing local officers to adjust the grid choices. In a way, they wanted the technology to be less technological. This contradiction again speaks to the desire to retain a component of craft, the freedom to determine for themselves where and how crime was to be addressed.

These contradictions suggest that, at least in terms of crime prediction, the truth about where crime may occur is less a metric to be measured, and more an impression to be perceived and experienced.

The findings of this research should be considered in light of its limitations. The experiment was conceived by leadership at the police department, with the academic researchers being brought in to ground the experiment in a robust methodological framework that would withstand scrutiny and provide meaningful results. The necessity of randomising districts and maintaining a strict limit of three grids per district, however, may have imposed too many constraints on the implementation.

Second, the presence of field researchers who observed and spoke with department members during the experiment could potentially alter the qualitative data itself. Some officers or supervisors may have been more or less forthcoming with their thoughts about the experiment with researchers present as opposed to other officers. Third, some police districts may have been visited more often by field researchers compared to others, which may have skewed the data one way or the other, as not all districts (or officers for that matter) reacted to or implemented the experiment in the exact same manner.

These potential limitations are potentially counter-weighted by some strengths. We generally followed a flexible coding approach (Deterding and Waters 2018). Coders worked independently on a subset of field notes, refined codes, came to agreement, then applied those codes to the bulk of the field notes. Further, the observational ride along schedules themselves, dates and districts, were determined via random assignment. Further, the lead author spent considerable time, both at headquarters and in the districts themselves, before, during, and after the experiment, hearing (brutally) honest opinions about research fatigue, questionable mid-level command support for the experiment, and officers' (generally low) levels of enthusiasm. Although this was not formal triangulation, it served the same purpose.

Within these limitations, this article makes the following contributions. First, it describes a number of insights that link with the previous work on technology adoption in policing. Contradictions that emerged during the experiment included simultaneous perceptions that the predictive policing software could never replicate the experience of police officers, even though many officers used the software and wished for it to be better. The findings underscore the cultural and operational complexities involved in introducing technological innovation into a police department.

Second, it provided a detailed illustration, in the context of technology innovation, of how different specific subcultural orders can create normative conflicts. Certainly, 'orders can conflict' (Herbert 1998, p. 349). And other research has highlighted some of these normative conflicts (Mastrofski *et al*. 1987). But this is, to the authors' knowledge, the first investigation of conflicts involving the normative orders bureaucratic control, competence, and safety, that has been carried out using information from the officers' perspective while they were implementing a new *predictive* technology. As such, the results here point toward an expanded treatment of the craft/technology conflict in studies of predictive policing, a treatment that explicitly considers normative subcultural components. Neglecting these subcultural dynamics runs the risk of under-appreciating the challenges when implementing predictive policing.

Third, the qualitative approach adopted here might provide important insights into ongoing officers' reservations about new technologies. As noted earlier, White *et al*. (2018) observed persistent concerns among close to or more than half of the officers involved with implementing BWCs in Tempe. Further qualitative work with officers in situations like this, trailing along and observing specific encounters and what the officers say, and following both those persistently concerned and those more accepting of the innovation, might help us better understand how these two types of officers are processing these changes.

Note

1. We thank an anonymous reviewer for these terms to describe officers' characterisations.

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