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AN INSTINCT FOR DETECTION: PSYCHOLOGICAL PERSPECTIVES ON CCTV SURVEILLANCE*

The aim of this article is to inform and stimulate a proactive, multidisciplinary approach to research and development in surveillance-based detective work. In this article we review some of the key psychological issues and phenomena that practitioners should be aware of. We look at how human performance can be explained with reference to our biological and evolutionary legacy. We show how critical viewing conditions can be in determining whether observers detect or overlook criminal activity in video material. We examine situations where performance can be surprisingly poor, and cover situations where, even once confronted with evidence of these detection deficits, observers still underestimate their susceptibility to them. Finally we explain why the emergence of these relatively recent research themes presents an opportunity for police and law enforcement agencies to set a new, multidisciplinary research agenda focused on relevant and pressing issues of national and international importance.

Introduction

CCTV monitoring is labour-intensive hard work that is very time-consuming and, compared with other control room duties, is not always perceived to be of high value by the operators (Helten & Fischer, 2004). Depending on the purpose of a CCTV system, much of the (supposedly 'higher value') tasks can involve coordination and post-event analysis rather than the pure detective work that many of the public might imagine is the main part of such monitoring. In the post 9/11, 7/7, Glasgow Airport context, CCTV systems will need to demonstrate far more ability to engage in proactive real-time surveillance and intervention than in what at present is mainly post-event analysis. It is important for the protection of the public and the preservation of public confidence in CCTV that the public believe the output of the cameras is being watched and operational responses are likely to be triggered by illegal activity occurring within view of the system. However, the reality is that CCTV camera output may not be watched as closely as we would like or expect, due to the conflicting roles of CCTV operators and the ever-increasing number of cameras feeding into control rooms (Gill & Sprigs, 2005). Optimising the human interface between CCTV input and command and control output is of course a critical goal for effective and efficient policing. It is crucial to meeting the new demands of the urban environment and global terrorism that precious time is optimised when human operators are actively observing CCTV systems. The key to success in this endeavour is to maximise detection rates for unexpected and unpredictable events. This issue is at the heart of modern police work in the twenty-first century. In this article, we suggest practical solutions based upon a multidisciplinary approach to design, implementation and evaluation of surveillance technology. In particular this approach should take account of the strengths and weaknesses of the human operator; new perspectives on this process can be gained from knowledge of psychology, viewed through the lens of the evolutionary legacy of the human primate.

The human visual system has evolved as an exquisitely sensitive and highly optimised detection system for avoiding predation and permitting hunting and gathering (Sekuler & Blake, 2002; Buss, 1999). A significant part of the 'hazard'-detection system in the brain is mediated by instinctual 'hard-wired' pathways that respond to motion through a system of 'subconscious' visual orienting reflexes (Sekuler and Blake, 2002; Buss, 1999). In addition, more recent primate visual development has evolved into a 'conscious' system of visual perception and recognition (Kilpatrick, 1961). However, our underlying biological 'hardware' has not changed significantly since our ancestors were hunting and gathering in the savannah many millennia ago (Buss, 1999; Orians, 1986; Tanner, 1983) and we are now left with our 'legacy' visual system trying to cope with the rapidly changing twenty-first-century environment. The fastest predator that our ancestors would have had to detect would have been a cheetah, but now we routinely drive cars and board planes and trains that go at much faster speeds than that of the fastest-moving animals. Most significantly of all, our previously natural, three-dimensional world is increasingly being substituted with a small, flat, two-dimensional 'window' onto an 'enhanced' world, that is, the TV or PC monitor.

The human psychological mechanism of adaptive problem solving (Tooby & Cosmides, 1992) has equipped us well as individuals to devise coping strategies for overcoming cognitive problems but, as we shall see, one of the biggest barriers to progress is our own overestimation of our visual detection abilities. While the statistical regularities of our ancestral environment permitted long-term solutions to be developed, the regularity of our evolutionary past (e.g. rain follows thunder, leopards attack from trees, etc.) has been superseded by a far more complex environment where extensive changes now occur readily at the click of a mouse or the switch of view from a camera. Psychology has powerfully demonstrated that our perceptual systems can fail to spot changes in these new environments (see Sekuler & Blake, 2002; Goldstein, 2007) where it has been found that the introduction of visual transients has dramatically reduced our ability to detect changes in naturalistic and synthetic visual scenes. In this article we give examples of how these perceptual failures can occur. We then discuss what implications these might have for policing, surveillance and detective work and what practitioners can do about them. We conclude with an agenda for multidisciplinary applied research to address the relevant emerging issues in their full context.

Evolution of Human Perception and the Modern Environment

Our 'environment of evolutionary adaptiveness' (Buss, 1994; Symons, 1979; Thornhill, 1997; Tooby & Cosmides, 1992) is anything from 200 million years old to just a few thousand years old. On the one hand, our visual system evolved to deal with illumination levels that were similar for many tens of millions of years (Walls, 1967; Cronly-Dillon and Gregory, 1991). On the other hand, our social intelligence evolved from family groupings arising only in the last two million years (Barkow, Cosmides, & Tooby, 1992). It is only in the last 5,000–10,000 years that most humans switched from a hunter-gatherer existence to an agricultural one (the increase in average size of an individual's society from groups of a few dozen individuals is more recent still). Accordingly, we have to accept that our brains, while not Neanderthal, are adapted to a much older, less complicated world than they now face. There simply haven't been enough generations to permit humans to adapt to the development of electricity and urbanisation (Barkow, *et al.*, 1992). Clearly, these older adaptations of social intelligence and problem solving skills have served humans well and the human race is thriving, but inevitably there are some aspects of human performance that cannot keep up with the breakneck speed of technological development, which is itself the outcome of human development in use of tools that now affects every aspect of human transactions.

Our neural circuits evolved to solve adaptive problems and give reproductive advantages in social and evolutionary contexts far removed from modern society. Until evolution has time to catch up with technology, those who design technology to best fit with the computational architecture of the human brain and body will have the competitive advantage with their system. A full awareness of this can influence design, policy, procedure and practice in surveillance technologies. For example, our evolved (hard-wired) visual structures cannot be changed substantially so display technology must be optimised to fit our visual physiology. Other aspects of visual perception can be seen as culturally specific, however, and so training in these contexts should be able to improve perception and recognition performance. For example, the so-called 'own-race bias' (ORB) in face recognition shows more accurate face recognition performance with faces of same-race individuals than with other-race individuals (Malpass & Kravitz, 1969; Kassin, Tubb, Hosch and Memon, 2001). The ORB is most frequently explained by the contact hypothesis, where repeated exposure to own-race faces leads to expertise in discrimination skills (Wright, Boyd & Tredoux, 2001). Switching from the face to general appearance, the tendency for fashion and dress trends to reflect the appearance of high-status individuals in society (Buss, 1999) seems to reflect transmitted cultural preferences rather than some more general human norm. Experienced CCTV operators report being able to sense when an individual is in a suspicious location, based on the appropriateness of their appearance for the viewing context (Manchester and London CCTV staff, personal communication, 2006, 2007).

What Perceptual Psychology Has to Say to the Police

The sceptic might say: 'How can psychology help me in my policing role?' The answer of course is that it already does. Face perception is central to police detective work and is also one of the core topics in psychology (for a review see Bruce & Young, 1998) and dramatic changes have already been made to police procedure and practice as a result of developments in tandem with cognitive scientists. E-fit technology (e.g. Frowd, Carson, Ness, Richardson, Morrison, McLanaghan & Hancock, 2005) has replaced the identikit; and there has been a clear and demonstrable feedback loop between the results of research and the change in methods. From an evolutionary perspective, our expertise with face perception should come as no surprise (Goldstein, 2007). A facility to recognise individuals from their face and to read emotions from expressions would provide obvious social advantages in competitive, deceptive and cooperative circumstances.

'Eye-witness' memory has also seen substantial research activity (for examples of this research see Cutler and Penrod, 1995; Wells, Malpass, Linday, Fisher, Turtle & Fulero, 2000; Memon, Vrij & Bull, 2004). This has resulted in tangible, long-term changes to procedure and practice, in the UK, via the Police & Criminal Evidence Act 1984, and in the USA, via the Report for Technical Working Group for Eyewitness Evidence, National Institute of Justice (Reno *et al.*, 1999). New protocols for interviewing witnesses and conducting identity parades include the use of open-ended questions when interviewing witnesses, avoidance of leading questions, and advising witnesses that the person they saw may, or may not, be present in a parade. Again, the exceptional human facility for memory would not in itself surprise the evolutionary psychologist; after all, hunting requires excellent spatial abilities and gathering requires excellent location and object memory (Silverman & Phillips, 1998).

The examples of memory and face recognition serve to show how far psychology has already permeated significant areas of policy, procedure and practice in policing in the context of memory, recall, and facial identification. The added value of CCTV evidence in detective work of course is that there is a permanent record of the events that took place. This relieves the burden on the remaining fallibilities of human performance, there is more time to make identifications and the sequence of events can be reviewed many times. For post-event analyses, this has transformed detective work: the rapid identification of the 7/7 and 21/7 bombers from tens of thousands of hours of video footage (Metropolitan Police, 2005) is a testament to the effectiveness of detective work with these additional memory tools. The power of CCTV as an evidence base in court has also resulted in a step change in the prosecution of criminals (the Bulger case being an early notable example (e.g. Thomas, 1993; NACRO, 2002)).

How effective can we expect online (or real-time) detection to be in CCTV, compared with the non-time-limited potential for post-event analysis? On the one hand, Troscianko and colleagues

(2004) have shown how encouraging the data can be. In an experiment involving real CCTV footage, they assessed the detection rates for experienced and novice CCTV operators for violent and antisocial behaviour. This investigation of 'intentionality' perception showed very high detection rates for violent incidents (when compared with matched control footage) for both groups of operators. Of course, we should expect human observers to be good at spotting violence, as we evolved in small groups where those who could interpret body language and intention would have had a social and reproductive advantage. On the other hand an observational study by Helten and Fischer (2004) in commercial CCTV rooms (such as in shopping malls) shows that only 15% of operator time is actually devoted to online surveillance. It is an empirical question as to how much time is spent by control room staff in police surveillance activity in both police and public control rooms. These facilities also function as command and control centres and of course such executive tasks inevitably steal resource time from pure surveillance. There is evidence that in police and public CCTV control rooms the most frequent tasks involve 'reactive' rather than proactive surveillance (Keval, 2006).

Evidently, research has a role in informing the development of procedures in surveillance technology. This is especially important because agencies can be prone to adopting lay-assumptions without relevant experimental data to back up the rationale for implementation of policy procedure and organisational practice. An example of a counter-intuitive experimental finding comes from the face recognition literature. In the recognition of unfamiliar faces from CCTV footage, somewhat surprisingly, Bruce and colleagues (1999) found no identification advantage for faces presented in colour over faces presented in black and white (B&W). Despite this effect, Davies and Thasen (2000) reported a widespread general view among public stakeholders of CCTV systems (such as businesses) that colour imagery would be more effective than B&W. Indeed the literature from scene recognition studies gives credence to this confidence; Wichmann, Sharpe and Gegenfurtner (2002) found a benefit for colour over B&W static natural scenes in a recognition memory test. The difference in these two experimental results is that the latter did not involve faces. The reason for the lack of a facial advantage can be explained by the evolution of colour vision in primates. While we might assume that colour mediates face recognition, it in fact appears to have evolved as a relatively late addition to the visual system (after face-specific coding in the brain would have become hard-wired); its use is widely accepted as mainly for frugivory (detecting ripe red fruit on a background of green foliage, see, e.g., Párraga, Troscianko, Tolhurst, 2002; Wolf, 2002; Lovell, Tolhurst, Párraga, Baddeley, Leonards, Troscianko, & Troscianko, 2005). In this way, an evolutionary perspective on human vision, allied to applied research in valid contexts, can be used to inform best practice in police surveillance tasks. Furthermore, an informed evolutionary psychological perspective should be useful in rebutting false assumptions from stakeholders about the effectiveness of systems in detecting crime.

It is worth emphasising, with another example, how important it is to collect data from the relevant visual domain rather than merely extrapolating from pure laboratory findings. Take the example of eye testing: using letter charts, your optician can gauge very accurately your visual acuity for reading. In the same way, letters (or points) can be flashed up in the visual periphery to test, literally, what you can see out of the corner of your eye. Anstis (1974) has published an elegant description of how the size of objects must be steadily increased (scaled) in the visual periphery to maintain equality of visibility. Accordingly, it should simply be a matter of arithmetic to determine how much can be seen by an observer on a large screen (such as the multiscreen data-wall prevalent in many control rooms): the further away from direct view, the bigger an incident has to be on the screen to be seen. However, recent evidence (Calvo & Lang, 2005; Calvo, 2006) shows that when pictures containing emotionally charged material (such as throttling or knife wielding interactions) are presented in the periphery or near-periphery (para-fovea), then visual sensitivity improves far more than for socially or emotionally neutral stimuli of the same visual dimensions. This, initially counter-intuitive, result should not surprise theorists as much as it does. Peripheral sensitivity for threatening behaviour would be a useful 'instinct' to evolve. It does pose challenges for the theoreticians trying to devise an account of how the visual system might be wired up, because they had assumed that all visual material enjoyed the same access rights to the optic nerves. In reality, the brain exhibits what is known as 'top-down processing' (Goldstein, 2007). Particularly important information gains privileged access by means of feedback connections in the brain (Felleman & van Essen, 1991). This benefit for violent content does give credence to the informal reports of control room staff that they can see events 'kicking off' 'out of the corner of their eye' (Manchester and London CCTV Staff, Personal communication 2006, 2007): an 'instinct' for detection if you will.

Change Blindness

A particularly relevant demonstration of the importance of motion perception in the detection of events comes from 'change blindness' research. This area has blossomed over the last 10 years to be among the most cited research topics in vision science (see Rensink, 2002; Simons & Rensink, 2005). At its simplest, change blindness is the surprising inability to spot large changes in the visual world during blinks, blanks and other visual interruptions. This effect has been widely documented in the literature and can be demonstrated in two main ways. The most astonishing way is in live action examples where an individual talking with an unsuspecting participant can literally swap places with another 'stooge' actor in mid sentence without the participant even noticing (Simons & Levin, 1998). Usually, some sort of brief visual interruption is all that is required to create this type of change blindness, hence it is sometimes called 'inattentional blindness' (Mack & Rock, 1998). For example, while asking for directions on a map on a university campus, an experimenter managed to trade places successfully with one of two men carrying a door between him and the poor unsuspecting subject in the experiment[1] (Simons & Levin, 1998). In another amusing experiment, students were duped while registering for an experiment at a reception desk. During the registration process, the receptionist would duck out of the way half-way through the transaction (ostensibly to file a piece of paper), to be replaced by another receptionist. When later asked about the registration process, 75% of the students failed to notice the change (Levin, Simons, Angelone, & Chabris, 2002).

This type of effect will come as no surprise to the readership of *Police Journal*, however. Misdirection of attention is the stock and trade of the con artist and the shoplifter (one distracts, the other one appropriates the property). In psychology prior to change blindness being publicised, the emphasis had been on how *efficiently* the visual system could perform in perceptual tasks. Crucially, however, these tasks involved simple highly stylised stimulus sets presented over a repeated number of trials, with a simple predictable task for the observer. The experimental paradigm that changed the position of change blindness in the literature was the so–called flicker paradigm (Rensink *et al.* 1997).[2] This type of experiment more readily mimicked the classic form of experiment in cognitive psychology than the

Simons and Levin (1998) study, with a series of images being presented to the participant each requiring a simple key-press decision from the viewer. The twist was the introduction of a very brief blink (a grey square occluding the scene every quarter of a second for 80 milliseconds). This blink duration is only a little more than the time taken for the blink of an eye. But when the experimenters moved/changed part of the image at every alternate blink, the results were surprising. Despite the changes being large (e.g. buildings, or objects moving or disappearing between views) people failed to spot the change for many alternations. Typically approximately 15 to 20 were required for accurate detection while without the blinks only 3 or 4 were required. Here was a demonstration of change blindness in a laboratory setting with a rigorous laboratory (flicker) paradigm: change blindness became a quantifiable scientific subject of inquiry.

From a theoretical point of view, the ‘flicker paradigm’ inspired an explosion of research papers looking at various aspects of human memory, perception, and performance (see Rensink, 2002; Simons and Rensink, 2005 for reviews). But, from a practical point of view, the ‘flicker paradigm’ demonstrations show why people fail to notice the changes: it is because of the disruption of the motion signal. Ordinarily, changes in the environment are accompanied by visual transients (motion) and, thanks to our environment of evolutionary adaptiveness, humans are exceptionally good at spotting motion (Regan, 2000). The grey field lasts long enough to mask any large changes in object luminance and detection breaks down. However, in the modern visual environment such blinks and interruptions are routine; distractions and interruptions are an ever-present menace. In the context of CCTV footage, the biggest disruption to motion signals is in the storage format (namely time-lapse format of 1 frame stored every 2 seconds). Scott-Brown and Mann (2005a, 2005b) have shown just how poor detection performance for suspicious and criminal behaviour can be when naïve observers view CCTV footage under highly time-constrained conditions. The experiment used footage of actors in real urban scenarios taking part in commonplace non-violent criminal activities. The results show that the display format itself can dramatically influence detection rates for incidents. Compared to full streaming video of 25 frames per second, 2-second ‘time-lapse’ recorded footage yielded far poorer detection rates (as low as 12% on average).

'Change Blindness' Blindness

As if this new-found evidence for change blindness is not enough, a second meta-phenomenon has also come to prominence in the literature: one that potentially has more likelihood of having impact on procedure and practice in the courts. Levin, Momen, Drivdahl and Simons (2000) have shown that even when people are aware of the conditions that make change blindness likely, they will still underestimate their own susceptibility to it, and most dramatically, Levin *et al.* have demonstrated this with their own students in their own lectures. Even psychology students (who have themselves taken part in demonstrations) with an understanding of the mechanisms still fail to appreciate the limitations of their visual systems. The experiments featured demonstrations of change blindness scenarios, followed by an assessment of perceived likelihood of spotting the changes. Despite being aware that average detection rates for changes in real and video scenes could be as low as 11%, students estimated that they would perform at a level of 83% correct. Rachlinski (2004) points out how this could have serious implications for juries in tort law cases, based on the expectations of what a reasonable person might expect. If a reasonable person's estimate of what a reasonable person might perceive is out by such a large amount, then the chance of a miscarriage of justice is large.

Summary of the Problems

The technological sophistication of modern surveillance systems is reassuringly expensive, but how confident should we be that human operators can keep pace with the increasing volume of images and information flowing through the modern control room? Post-industrial life presents challenges that humans simply have not had enough time to adapt to genetically. Despite our own impressions of the richness of visual representation, our own visual performance can be surprisingly poor in the complex visual environments that we experience in the modern world. Experimental psychology is beginning to focus on meaningful ways of helping resolve or minimise these difficulties. An increasing focus on applied psychology is helping practitioners to anticipate the circumstances under which perceptual failures are most likely to occur. As digital technology and photography has improved, naturalistic scenes are now more widely available to cognitive psychology (Simons and Rensink, 2005). Nevertheless, in comparison with the examples of faces and eyewitness memory already mentioned, studies of criminal detection ability in real-world scenarios with real-world, live-action incidents lag far behind in both scale and scope. Part of this is simply because the technology is so new that the issues did not exist before. However, CCTV costs are now such a large proportion of public and private expenditure on crime reduction (NACRO, 2002) that these contexts demand an equivalent expansion of research into visual performance in multiscreen, multi-input, multi-action viewing contexts.

The Solution

Practitioners should be particularly aware of the implications of ongoing research for policy, procedure and practice. This should be informed by a variety of observational and evaluative research methods designed to both assess and develop effectiveness in modern detective work. This should include laboratory-based theoretically informed experimental work as well as field-observations. The benefit of observational studies is that they are not constrained by any particular agenda and because of this are particularly important in hypothesis generation (Cronin & Reicher, 2006). It should be emphasised that investigators and stakeholders should seek integrated solutions that require a breadth of analysis to interpret all the nuances that span traditional disciplines. Such a multi-disciplinary approach will overcome the scope limitations of individual discipline research methodologies, and the unintended consequences that can arise from such artificial divisions. This research agenda implicitly recognises that CCTV is not a panacea for all detective work; without appropriate manpower glaring omissions will sometimes occur (and be recorded for posterity).[3] Worse still, if there is not the right level of command and control in place then even when detections do occur the appropriate response may not be actioned by the executive level of the system. The relationship between senior and junior staff, police and council staff requires the most in-depth investigations to mitigate against any failures (Cronin & Reicher, 2006). By creating a research corpus that shows how and when humans can be deployed *most* effectively it will be possible to challenge the belief that time spent simply watching the screens is somehow low-value work (Helten & Fischer, 2004). As noted by Keval (2006), the tendency for control rooms to engage in 'reactive' rather than 'proactive' surveillance means that officers and staff are responding to events rather than anticipating them. Any effective means of shifting this balance of activity will improve detection and workflows.

Evidently there is a clear benefit to be had from CCTV systems in post-event analysis settings, although the live use of surveillance for low-level crime is dependent on manpower to succeed. For Friday night trouble-spots or busy high streets, CCTV control rooms seem to make a reliable difference (Gill & Spriggs, 2005). Disturbances can be easily spotted and resources directed to break them up. Known offenders can be tracked and intercepted as soon as they transgress. However, for the many other channels not monitored online,[4] the benefits are not so clear. If CCTV is installed in areas but no law enforcement is seen to be enabled as a consequence of law breaking then the perception of the efficacy of the system can change to the detriment of community faith in the system (see, e.g., Gill & Spriggs, 2005). Worse still, community intervention can be inhibited by the diffusion of responsibility that may arise from the presence of the cameras. People may assume that illegal activity will be acted upon if conducted in the presence of surveillance cameras (but someone has to be watching the cameras before action can take place; or someone has to report the event before post-event analysis can enable action). For low-level crime, the human resources required to initiate post-event analysis may inhibit the path to action (e.g. Urquhart, 2005). In addition to multidisciplinary analyses of these processes, longitudinal analyses must begin now to validate the changes in policy, procedure and practice that are already emerging from the research base.

Instinct Blindness: Design for Living Operators

End-users of equipment should embrace the known skills and attributes of the human observer and insist that equipment and systems design be optimised for operators so that they work with the operators rather than against them. 'Instinct blind' designers ignore the lynchpin (the human) at their peril; likewise procurers of systems must keep the effectiveness of the human component to the forefront, rather than simply assuming that the 'management' of staff can solve new interface problems (Gill & Spriggs, 2005). For example, surveillance tasks must minimise visual disruption. The arrangement of monitors and the transitions from camera views can demonstrably influence overall detection levels (Scott-Brown & Mann, 2005a, 2005b); but how these effects translate to multiple independent screens on a data-wall is as yet uninvestigated and must be empirically determined (Ahmad *et al.*, 2005).

Instinct Awareness

Earlier we discussed how performance in detecting violence has been shown to be good, even in those not experienced at such detection tasks (Troscianko *et al.*, 2004). The development and management of effective CCTV control rooms will benefit from an overarching theoretically informed knowledge base of the strengths and weaknesses of the human operators. While having an evolved psychological mechanism well suited to violence detection, humans are not so efficient at detecting changes in unfamiliar contexts or for static inanimate objects. Hence the difficulty in spotting unattended bags or vehicles (e.g. Scott-Brown & Mann, 2005a, 2005b). Human visual systems are optimised to dodge rapidly emerging threats and potential hazards and to track animals over space and time for hunting: breaking camouflage through motion processing is a key aptitude (Regan, 2000). Anecdotal evidence suggests that CCTV operators are highly skilled in 'tracking' known suspects once identified, even across multiple camera sites and viewing monitors (Manchester and London CCTV operators, personal communication 2006, 2007). Human vision is also highly evolved to perform visual foraging for food. Hence our colour vision excels at distinguishing ripe (red) fruit on a forest canopy (green) background (Wolf, 2002; Párraga, *et al.*, 2002; Lovell, *et al.*, 2005).

This evolved psychological-mechanisms perspective on surveillance generates testable predictions, for example, that social and emotionally charged events should be easier to detect (Calvo & Lang, 2005) on CCTV systems. The suggestion that women may be particularly good at certain CCTV detection tasks (Troscianko *et al.*, 2004) is supported by the evolutionary arguments of (Silverman & Phillips, 1998) that suggests women had greater need for location and object memory. This type of hypothesis can become part of a wider empirical evaluation of operator skills and aptitudes. For example, evolutionary psychology can also inform and educate as to the differing causes of violence in various contexts. For example, two of the most common causes of male-on-male violence are: (1) defence of status, reputation and honour in a peer group; (2) sexual jealousy and intra-sexual rivalry. Intra-sexual rivalry can also explain many of the contexts involving women's violence against women. These evolutionary perspectives accompany the cultural perspectives that help the interpretation of behaviour (Buss, 1999).

In tandem with theoretically informed research in ecologically valid contexts, training methods can be developed and informed by the use of real (or highly realistic) contexts. Clearly the use of real control rooms and real streets for training is not always possible because of issues arising from confidentially and anonymity of the data sets being viewed; and the likelihood of their being required in subsequent court proceedings. Nevertheless, the challenges facing command and control staff in metropolitan CCTV rooms can be as complex as flying a plane but less predictable. Fortunately, the technological costs of such simulators are far fewer than those for a flight simulator because there is no need to mimick the effects of cabin motion. The corollary is that the interaction with different levels of command is more complex and merits additional research scrutiny (e.g., Cronin & Reicher, 2006).

Conclusion

What we are suggesting is not some far-distant aspiration; developments can be made immediately within the contexts of existing detection systems. There has never been a better time to access or commission applied focused research on policing issues. Research councils have become proactive in the setting of research schemes to stimulate knowledge transfer to better exploit their expenditure (e.g. Coates, 2006).

The recent ‘Networks in Crime Prevention and Detection’ programme funded by the UK Engineering and Physical Sciences Research Council is just one example of how the research agenda has become focused on technological innovation in design against crime. However, care must be taken to match this expansion of research with investment in the human aspects of detective work. After all, this is what policing is really all about. New technology brings with it new demands on the user: some beneficial and some with negative consequences. While computational solutions are now in development to automate the visual-detection processes for suspicious activity (e.g., Dee & Hogg, 2004), there will always be people watching the output of the watching machines. Once technology matures, it is still the human that is always the expensive component (and human errors are particularly costly). Establishing the most efficient and effective way of interacting with new systems therefore will always pay the biggest dividends in the long run. Central to exploiting the new research climate is the necessity to perform research in the appropriate context. Instead of simply trying to extrapolate from laboratory examples using unrelated stimuli, detection researchers must use stimuli appropriate for the detection task. As Calvo (2006) has shown, violent or emotionally charged scenes do attract more attention than would ordinarily be expected based on what is known about the sensitivity of the human visual system. Throughout this article we have discussed various psychological processes and the key conceptual contribution of our argument is the notion that some of these are best understood as 'Evolved Psychological Mechanisms' (Buss, 1999) and that this level of analysis can inform the enhancement of policy, procedure and practice at the strategic, tactical and operational levels of decision making.

In conclusion, well-informed and well-designed research can benefit detective work; and it is incumbent upon the *Police Journal*'s readership to influence the research agenda. This can be achieved through police bodies such as the Home Office Police Scientific Development Branch or the Scottish Institute for Policing Research in the UK or through the equivalent international structure. Universities are there to develop the research agenda through dialogue with you. Often the most interesting theoretical questions can be driven by practical problems. Funding bodies are always focused on commissioning high-quality research in strategically important areas and the opportunity now exists for the police to set the research agenda much more proactively than before, to the benefit of police, academia and wider society.

Note

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1. These examples, along with many others are available to view online at Dan Simon's website <http://viscog.beckman.uiuc.edu/djs_lab/demos.html>. They are best viewed with a colleague, to introduce an element of competition, and social pressure.
2. Entertaining examples of the flicker paradigm are available from Ron Rensink's website <http://www.psych.ubc.ca/~rensink/flicker/>.

3. A example of such a misperception is the well-publicised intrusion of protesting 'super-heroes' into restricted areas of central London (Johnston & Alleyne, 2004).
4. Many more channels are archived for 30 or 90 days in a time-lapse format. Scott-Brown and Mann (2005a, 2005b) showed how detection rates for thefts unknown to the observer were significantly poorer in time-lapse formats.

References

Ahmad, K., Battersby, S., Bryan, M., Scott-Brown, K.C., Hogg, D., Neil, D., Petillot, Y., Rogerson, M., Troscianko, T., Walters, L. Neary, C., Howard, E. and White, D. (2005) 3rd Meeting of Surveillance: Evaluation, Research, Validation and Exploitation Network. Manchester, 18 April.

Anstis, S.M. (1974) 'A Chart Demonstrating Variations in Acuity with Retinal Position' *Vision Research* 14: 589–92.

Barkow, J., Cosmides, L. and Tooby, J. (1992) *The Adapted Mind: Evolutionary Psychology and the Generation of Culture.* New York: Oxford University Press.

Bruce, V. and Young, A.W. (1998) *In the Eye of the Beholder: The Science of Face Perception.* Oxford: Oxford University Press.

Bruce, V., Henderson, Z., Greenwood, K., Hancock, P., Burton, A. M. and Miller, P. (1999) 'Verification of Face Identities from Images Captured on Video' *Journal of Experimental Psychology: Applied* 5: 339–60.

Buss, D.M. (1994) *The Evolution of Desire: Strategies of Human Mating*. New York: Basic Books.

Buss, D.M. (1999) *Evolutionary Psychology: The New Science of the Mind*. Boston, MA: Allyn & Bacon.

Calvo, M.G. (2006) 'Processing of Emotional Visual Scenes outside the Focus of Spatial Attention: The Role of Eccentricity' *Visual Cognition* 13(6): 666–76.

Calvo, M.G. and Lang, P.J. (2005) 'Parafoveal Semantic Processing of Emotional Visual Scenes' *Journal of Experimental Psychology-Human Perception and Performance* 31(3): 502–19.

Coates, C. (2006) *EPSRC strategic plan for 2006*. Engineering and Physical Sciences Research Council. Available from: <http://www.epsrc.ac.uk/CMSWeb/Downloads/Publications/Corporate/EPSRCSP06.pdf>. Accessed 12/3/07.

Cronin, P.D.J. and Reicher, S.D. (2006) 'A Study of the Factors that Influence how Senior Officers Police Crowd Events: On Side outside the Laboratory' *British Journal of Social Psychology* 45: 175–96.

Cronly-Dillon, J.R. and Gregory, R.L. (eds) (1991) *Evolution of the Eye and Visual System*. Boca Raton, FL: CRD Press.

Cutler, B.L. and Penrod, S.D. (1995) *Mistaken Identification: The Eyewitness, Psychology, and the Law*. New York: Cambridge University Press.

Davies, G. and Thasen, S. (2000) 'Closed-Circuit Television: How Effective an Identification Aid?' *British Journal of Psychology* 91: 411–26.

Dee, H. and Hogg, D. (2004) 'Detecting Inexplicable Behaviour', British Machine Vision Conference, Kingston, 2004. Available from: <http://www.scs.leeds.ac.uk/dch/papers/dee/bmvc2004.pdf>. Accessed 3/3/07.

Felleman, D.J. and van Essen, D.C. (1991) 'Distributed Heirarchical Processing in the Primate Cerebral Cortex', in A. Peters and E.G. Jones (eds.), *Cerebral Cortex* 9: 1–47. New York: Plenum.

Frowd, C.D., Carson, D., Ness, H., Richardson, J., Morrison, L., McLanaghan, S. and Hancock, P.J.B. (2005) 'A Forensically Valid Comparison of Facial Composite Systems' *Psychology, Crime and Law* 11(1): 33–52.

Gill, M. and Spriggs, A. (2005) 'Assessing the Impact of CCTV' *Home Office Research Study 292*. Home Office Research, Development and Statistics Directorate.

Goldstein, E.B. (2007) *Sensation and Perception*, 7th edn. Belmont, CA: Thomson Wadsworth.

Helten, F. and Fischer, B. (2004) 'Reactive Attention: Video Surveillance in Berlin Shopping Malls' *Surveillance & Society* 2(2/3): 323–45. Available from: <http://www.surveillance-and-society.org/cctv.htm>.

Johnston, P. and Alleyne, R. (2004) 'Batman Zaps Security at the Palace' *The Daily Telegraph*, 14 September.

Kassin, S., Tubb, V.A., Hosch, H.M. and Memon, A. (2001) 'On the 'General Acceptance' of Eyewitness Testimony Research: A New Survey of the Experts' *American Psychologist* 56: 405–16.

Keval, H. (2006) 'CCTV Control Room Collaboration and Communication: Does it Work?', in *Proceedings of Human Centred Technology Workshop*, 11–12 September, Brighton, UK. Available from: <http://hornbeam.cs.ucl.ac.uk/hcs/teaching/GA10/lec6extra/HCT_KEVAL.pdf>. Accessed on 17/3/07.

Kilpatrick, F.P. (1961) *Explorations in Transactional Psychology*. New York: New York University Press.

Levin, D.T., Momen, N., Drivdahl, S.B. and Simons, D.J. (2000) 'Change Blindness Blindness: The Metacognitive Error of Overestimating Change-Detection Ability' *Visual Cognition* 7: 397–412.

Levin, D.T., Simons, D.J., Angelone, B.L. and Chabris, C.F. (2002) 'Memory for Centrally Attended Changing Objects in an Incidental Real-World Change Detection Paradigm' *British Journal of Psychology* 93: 289–302.

Lovell, P.G., Tolhurst, D.J., Párraga, C.A., Baddeley, R.J., Leonards, U., Troscianko, J. and Troscianko, T. (2005) 'Stability of the Color-Opponent Signals under Changes of Illuminant in Natural Scenes' *Journal of the Optical Society of America* 22(10): 2060–71.

Mack, A. and Rock, I. (1998) *Inattentional Blindness*. Cambridge, MA: MIT Press.

Malpass, R.S. and Kravitz, J.(1969) 'Recognition for Faces of Own- and Other-Race Faces' *Journal of Personality and Social Psychology* 13: 330–4.

Memon, A., Vrij, A. and Bull, R. (2004) *Psychology and Law*. Wiley: Chichester.

NACRO (2002) *To CCTV or Not to CCTV? A Review of Current Research into the Effectiveness of CCTV Systems in Reducing Crime*. London, NACRO. Publication Number 2002062800.

Metropolitan Police (2005) 'Police Investigation Continues into the 7/7 Bombings' *Metropolitan Police Bulletin* 222, 18 July 2005. Available from: <http://cms.met.police.uk/news/major_operational_announcements/terrorist_attacks/police_investigation_continues_into_the_7_7_bombings>. Downloaded: 17/3/07.

Orians, G. (1986) 'An Ecological and Evolutionary Approach to Landscape Aesthetics', in E.C. Penning-Roswell and D. Lowenthal (eds.), *Landscape Meaning and Values*, 3–25. London: Allen & Unwin.

Párraga, C.A., Troscianko, T. and Tolhurst, D.J. (2002) 'Spatio-chromatic Properties of Natural Images and Human Vision' *Current Biology* 12(6): 483–7.

Rachlinski, J.J. (ed.) (2004) 'Misunderstanding Ability: Misallocating Responsibility', in: D. Levin (2004), *Thinking and Seeing: Visual Metacognition in Adults and Children.* Cambridge, MA: MIT Press.

Regan, D. (2000). *Human Perception of Objects: Early Visual Processing of Spatial Form Defined by Luminance, Colour, Texture, Motion and Binocular Disparity*. Sunderland, MA: Sinauer Associates.

Reno, J., Fisher, R.C., Robinson, L., Brennan, N. and Travis, J. (1999) *Eyewitness Evidence*. Rockville, MD: National Institute of Justice.

Rensink, R.A. (2002) 'Change Detection' *Annual Review of Psychology* 53: 245–77.

Rensink, R.A., O'Regan, J.K. and Clark, J.J. (1997) 'To See or Not to See: The Need for Attention to Perceive Changes in Scenes' *Psychological Science* 8: 368–73.

Scott-Brown, K.C. and Mann, D.P. (2005a) 'On the Costs and Benefits of Display Format in a Video-Based Observation Task' *Spatial Vision* 18: 508–9.

Scott-Brown, K.C. and Mann, D.P. (2005b) 'On the Costs and Benefits of Display Format in a Video-Based Observation Task' *Proceedings of the 2nd Symposium on Applied Perception in Graphics and Visualization, 95 Archive*, 157.

Sekuler, R and Blake, R. (2002) *Perception*. 4th edn. Boston, MA: McGraw-Hill.

Silverman, I. and Phillips, K. (1998) 'The Evolutionary Psychology of Spatial Sex Differences', in C. Crawford and D.L. Krebs (eds),

Handbook of Evolutionary Psychology, 595–612. Mahwah, NJ: Erlbaum.
Simons, D.J. and Levin, D.T. (1998) ‘Failure to Detect Changes to People during a Real-World Interaction’ *Psychonomic Bulletin & Review* 5: 644–9.
Simons, D.J. and Rensink, R.A. (2005) ‘Change Blindness: Past, Present, and Future’ *Trends in Cognitive Sciences* 9: 16–20.
Symons, D. (1979) *The Evolution of Human Sexuality*. Oxford: Oxford University Press.
Tanner, N.M. (1983) ‘Hunters, Gatherers, and Sex Roles in Space and Time’ *American Anthropologist* 85: 335–41.
Thomas, M. (1993) *Every Mother’s Nightmare: The Killing of James Bulger*. London: Pan.
Thornhill, R. (1997) ‘The Concept of an Evolved Adaptation’, in G.R. Bock and G. Cardew (eds), *Characterizing Human Psychological Adaptations*, 4–22. Chichester, UK: Wiley.
Tooby, J. and Cosmides, L. (1992) ‘Psychological Foundations of Cultures’, in J. Barkow, L. Cosmides and J. Tooby (eds), *The Adapted Mind*, 19–136. New York: Oxford University Press.
Troscianko, T., Holmes, A., Stillman, J., Mirmehdi, M., Wright, D.B. and Wilson, A. (2004) ‘What Happens Next? The Predictability of Natural Behaviour Viewed through CCTV Cameras’ *Perception* 33: 87–101.
Urquhart, F. (2005) ‘Cameras a Flop as 90% of Bus-Lane Culprits Get Off’ *The Scotsman*, Wednesday 16 March. Available from: <http://news.scotsman.com/scotland.cfm?id=283882005>. [Accessed 9 March 2007].
Walls, G.L. (1967) *The Vertebrate Eye and its Adaptive Radiation*. New York: Hafner.
Wells, G.L., Malpass, R.S., Lindsay, R.C.L., Fisher R.P., Turtle, J.W. and Fulero, S.M. (2000) ‘From the Lab to the Police Station: A Successful Application of Eyewitness Research’ *American Psychologist* 55: 581–98.
Wichmann, F.A., Sharpe, L.T. and Gegenfurtner, K.R. (2002) ‘The Contributions of Color to Recognition Memory for Natural Scenes’ *Journal of Experimental Psychology-Learning Memory and Cognition* 28(3): 509–20.
Wolf, K. (2002) ‘Visual Ecology: Coloured Fruit is What the Eye Sees Best’ *Current Biology* 253–5.
Wright, D.B., Boyd, C.E. and Tredoux, C.G. (2001) ‘A Field Study of Own-Race Bias in South Africa and England’ *Psychology, Public Policy, and Law* 7: 119–33.