
A REVIEW OF STREET LIGHTING EVALUATIONS: CRIME REDUCTION EFFECTS

by

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Abstract: *Consideration of the literature concerning street lighting effects on crime yields the following conclusions: (1) Precisely targeted increases in street lighting generally have crime reduction effects. (2) More general increases in street lighting seem to have crime prevention effects, but this outcome is not universal. Older and U.S. research yield fewer positive results than more recent U.K. research. (3) Even untargeted increases in crime prevention generally make residents less fearful of crime or more confident of their own safety at night. (4) In the most recent and sophisticated studies, street lighting improvements are associated with crime reductions in the daytime as well as during the hours of darkness. (5) The debate about lighting effects has served to preclude a more refined analysis of the means by and circumstances in which lighting might reduce crime. Our aim should now be to use context-appropriate lighting schemes as part of a full repertoire of crime reduction tactics. Recommendations based upon a strategic view of current crime reduction policy are made about how lighting effects could be clarified and elaborated. The provisions of the British Crime and Disorder Act 1998 constitute a potential vehicle for lighting programmes operating within crime reduction schemes generally.*

INTRODUCTION

After discussions with British Home Office officials and representatives of the lighting industry, a report was commissioned on the relationship between street lighting and crime. For the last 10 years, and in the face of a British research base increasing in both volume and quality, the perception has persisted of a Home Office view that street lighting is not relevant to crime. I have yet to find a Home Of-

fice official who admits to believing this in any but a massively qualified way, but the sense of Home Office scepticism is certainly there.

It is possible, on the basis of the content and tone of two publications of the now-defunct Home Office Crime Prevention Unit, in particular its Papers #28 and #29, to see how a sceptical view could have been inferred. Indeed, complex material in memory tend to be reduced to a few simple observations. Anyone reading the publications in question would certainly have to oversimplify to take from those reports the message that street lighting was not helpful in crime control. Equally certainly, the content of those reports would lead that to be the simple conclusion requiring the *least* oversimplification. One of these reports (#29) was a review of research. The other (#28) presented original data later extensively cited as inimical to the cause of lighting as a crime reduction measure.

Reading the research evidence now leads to the inescapable conclusion that street lighting can help in crime control. The sensible question is no longer whether lighting is relevant to crime reduction, but rather how one can identify the circumstances and settings in which it is most helpful and economical in relation to impact, and how one should use lighting in combination with other measures to optimise its effect. Crime reduction has been bedevilled by the tendency to polarise measures into those which will be helpful in all circumstances and those which will not be helpful in any, a process that the evaluative process has often mirrored and accelerated. In recent years in the U.K., closed circuit television (CCTV) has sadly fallen into the first category, and Neighbourhood Watch into the second (see Koch, 1998, for a pertinent discussion).

There is no such thing as an all-purpose crime prevention measure. Recognition of this point is of fundamental importance. The most physically secure house or business can be penetrated if the perpetrator can be sure that fear or indifference means that no one will raise the alarm, however long the crime takes to commit and however much noise is made during its commission. The most insecure house or business may be safe if located in small, watchful and self-confident communities. The most active drug dealer will operate in safety from enforcement if a community and its police tolerate the trade or, alternatively, are paralysed by fear of, or corrupted by money from, the dealers. Safes previously impregnable ceased to be so with the advent of the thermic lance. No security measure on plastic cards, up to and including photographs, will reduce plastic fraud at the point of sale if retail staff fail to look at them. Likewise, no public place, however well lit, will be crime free if offenders have

good reason to believe that they will not be recognised, or, if recognised, will not be reported to the police, or, if reported will escape meaningful criminal justice outcomes. While still conditional, some crime control measures will be effective over a broad range of conditions. For example, the presence of large numbers of stewards and police is likely to reduce trouble at all but the most volatile soccer matches. To say that lighting effects are conditional is not to say that they will not be common.

Taking stock of the position of lighting in the repertoire of crime prevention techniques is timely for two reasons. The first of these is unarguable. The second is not, but merits inclusion.

- (1) The recent passage of the Crime and Disorder Act in the U.K. is crucial, with its obligation placed upon locally responsible bodies (comprising local authorities and police) to both develop and implement crime prevention plans, and themselves not to act in ways that facilitate crime and disorder. Since street lighting is a matter under local authority control, it would be extremely sad if the role of lighting in preventing crime were neglected at a time when there is, perhaps for the first time, extrinsic motivation for local bodies to control the levels of crime that their area suffers. Expressing a personal view, locally responsible bodies seem to be in danger of being monopolised by people-processing agencies (like youth justice and probation) to the exclusion of trading standards, environmental health and other local authority functions engaged in the manipulation of places and commerce to render them less criminogenic. The neglect of lighting would be another culpable omission from the crime control armoury alongside the others mentioned.
- (2) The development of Virtual Reality techniques enables a much more complete and sophisticated simulation of lighting effects. If layered alongside crime and disorder data in recognisable and manipulable urban landscapes, lighting can be more precisely deployed for local crime control purposes. The geocoding of crime events and the installation of Geographic Information Systems have advanced only haltingly within the police service. Where it has occurred, the interpretive burden is massively lightened by Virtual Reality, which can depict attributes of frequent crime scenes more satisfactorily than can mapping. Virtual Reality will be mentioned again in the recommendations section of this report.

CRIME AND LIGHTING RESEARCH AND ITS FREQUENT REVIEW

The relationship between lighting and crime is perhaps unique in the number of reviews published per original study carried out. Why is this topic, which is relatively little studied, so thoroughly reviewed? The answer is probably its combination of clear policy relevance, general consensus as to results, but disagreement about what the implications of these results might be. In the light of the rash of reviews, the present offering is an attempt to summarise the data available, the policy conclusions that may safely be based upon them, and the best means by which light may be cast (literally and metaphorically) in the cause of crime prevention.

Perhaps the two most remarkable things about a topic that is generally seen as contentious are:

- (1) The relatively high level of agreement to be found in the research.
- (2) The lack of research effort expended in establishing the circumstances and conditions in which lighting may become more sophisticated in its crime prevention role.

Given the tensions surrounding this topic, the reader may be surprised to learn that all the reviews seem to agree on three things:

- (1) *The bad news:* untargeted general increases in street lighting do not always have overall crime prevention effects, although many do. The division is by epoch and country, with older and U.S. research yielding fewer positive results.
- (2) *The good news:* targeted increases in street lighting generally have crime reduction effects.
- (3) *The stale news:* even untargeted increases in crime prevention generally make residents less fearful of crime or more confident of their own safety at night.

The first two conclusions have been expressed in terms varying from the optimistic to the decidedly downbeat. Among the more downbeat, Tien et al. (1979:93) concluded "The paucity of reliable and uniform data and the inadequacy of available evaluation studies preclude a definitive statement regarding the relationship between street lighting and crime."

To a large extent, however, the reviewers engineered the paucity they bemoan by taking a narrow and formulaic approach to evaluation, which led them to discard the vast majority of studies that came

to their attention. Ramsey and Newton (1991), elaborating on Ramsey (1989), conclude:

Better lighting by itself has very little effect on crime. There are some limited local 'blackspots' where improved lighting may have a modest impact on crime and perhaps a larger one on incivilities. Also, in conjunction with other measures, better lighting may help to improve an area. Indirectly, this may conceivably assist in reducing crime — although such an outcome is not guaranteed. There is no scope for reducing crime on any broad basis simply by investing in better street lighting [p.24].

Eck (1997:326) opines "Not much has changed since Tien and his colleagues...gave their critical assessment of the impact of lighting on crime." However, Poyner and Webb (1993) generated a rating system for crime control measures, and found lighting (street or otherwise) to be effective as a general crime control measure in most of the studies reviewed, including six of seven studies of residential burglary, two of two studies of commercial burglary, three of four studies of vehicle crime, and three of five measures against robbery. A more recent example (LaVigne, 1994) shows the relevance of illuminating petrol station forecourts, among other variables, to the level of driving off without paying. The La Vigne work is a neat illustration of the relevance of lighting level in *specific* contexts alongside other factors.

The most recent review, that of Painter (1996a), is both the most optimistic and the most complete in terms of research coverage. Painter's own extensive previous work, and work by others that she coordinated, showed *at least* short-term effects in circumscribed areas. The research strategy she adopted, that of showing many localised effects, was very defensible. In aggregate, her work showed many local crime reductions associated with relighting.

As for the "stale news," the effect of lighting upon crime fear, this seems uncontentious (see, for example, Atkins et al., 1991; Vrij and Winkel, 1991; Painter 1996b). "Lighting is still recognised by the Home Office as having an important role, although primarily in terms of the reduction of fear rather than crime" (Ramsey and Newton 1991:22). This may be healthy, insofar as crime fear is greater than the real hazard from crime. It may also be unhealthy, in that crime fear moves one to take prudent avoiding action. To reduce crime fear or perceived safety without reducing crime hazard may not be doing citizens any favours. For that reason, the remainder of this document deals with crime *hazard* rather than crime fear.

CHILDREN OF LIGHT AND DISCIPLES OF DARKNESS¹

An understanding of the relationship between lighting and crime has been beset by two problems. Both have the same result in practice. The first has been dogmatism about the effect of lighting in preventing crime. Writing in the highly influential *Handbook of Loss Prevention and Crime Prevention*, edited by Lawrence Fennelly, Girard (1982:96) contends that "good lighting is the single most cost effective deterrent to crime." In the equivalent chapter of the third edition of the same handbook, in a section headed "The Miracle of Light" Girard (1982:253) contends "Police officers are, of course, aware of the effect that lighting has in reducing criminal opportunity. Nonetheless, it is interesting to note that a variety of studies and experiments that have documented this fact. ...[as well as] experience has shown the close relationship between illumination and crime."

Fennelly (1996:38) himself is no less confident:

What would happen if we switched off all the lights at night? ... Such a foolish act would create an unsafe environment. Senior citizens would never go out and communities would have an immediate outbreak of thefts and vandalism. Commercial areas would be burglarized at an uncontrollable rate. Therefore, lighting and security go hand in hand. The above example may seem to be far-fetched, but in fact installation of improved lighting in a number of cities has resulted in the following:

1. Decrease in vandalism;
2. Decrease in street crimes;
3. Decrease in suspicious persons;
4. Decrease in commercial burglaries;
5. In general, a reduction in crime.

Fennelly cites no evidence for these assertions. In a similar vein, *The London Times* opined in its 1st September 1989 edition: "Recent research has demonstrated what was obvious to common sense already, that a systematic improvement in street lighting can bring about a substantial reduction in street crime" (p.2).

The dogmatism of the disciples of darkness is of a different kind, and is primarily reactive. It stresses the limitations in method, the area experiencing change and the time scale of demonstrations of lighting effects, rather than seeking to develop a fuller understanding of the mechanisms involved.² Although this has never been openly acknowledged to the author, the reactive dogmatism also seems based upon the suspicion that the government is being railroaded by

the lighting industry into taking costly measures of uncertain crime-control efficacy.

There is a degree of justification for both extreme positions. For those who, day-to-day, must do something concrete about local crime problems, the installation of lights has obvious face validity. Lighting thus features prominently in security handbooks (e.g., Fennelly, 1982, 1996; Lyons, 1988; Hylton, 1996). Further, attention to lighting parallels the high importance that citizens assign to light as a crime control measure. For example, Bennett and Gelsthorpe (1996) found improved street lighting to be second only to increased police foot patrols and ahead of CCTV and private security patrols among preferred crime prevention measures. By contrast, for those exercising stewardship of public money, good evidence about effects should be necessary before money is spent, although one is tempted to ask where rigorous standards went in the headlong rush to CCTV deployment.

When opinion gets polarised, the sensible questions about the **range of application of lighting measures get neglected. For believers**, lighting just *does* prevent crime. In the extreme case, whatever the question, the answer involves lighting. In the absence of the believers' specification of how lighting works its magic, sceptics carry out evaluations that believers regard as unrealistic and that indeed could not be otherwise, given the lack of detailed insight into the mechanisms concerned.³ The effect of combined dogmatism and woolly thinking about how lighting might work in reducing crime has been to preclude the more precise and necessary questions about what kind of lighting, deployed how and under what circumstances, would optimise the cost-efficiency of its crime prevention impact.

The unfortunate consequences of polarised thinking will be illustrated by detailed consideration of the large-scale research project most often cited as indicating the lack of association between lighting and crime. The Home Office's Crime Prevention Unit Paper #28, authored by Stephen Atkins et al., arguably marks the watershed in perceived official thinking about crime and street lighting, and remains the lone major British study to be frequently cited against the crime reduction possibilities of street lighting.

THE ATKINS (1991) CRIME PREVENTION UNIT PAPER

Sceptics of the effects of street lighting on crime rely heavily on a major study conducted by a team at the University of Southampton and published as Home Office Crime Prevention Unit Paper, #28,

authored by Atkins et al. (1991). Because of its central role in expressed scepticism, this paper will be dealt with at some length. In 1985, the London borough of Wandsworth began a programme of re-lighting the borough "to a very high standard, partly with the aim of crime prevention" (Atkins et al., p. viii). An analysis of crime reported to the relevant Metropolitan Police divisional areas contrasted the year before relighting with the year following relighting. The central conclusion was that "(n)o evidence could be found to support the hypothesis that improved street lighting reduces reported crime. Although some areas and some crime types did show reductions in night-time crime relative to the daylight control, the dominant overall pattern, from which this study draws its authority, was of no significant change*" (Atkins et al., p. viii).

One must preface comments about the Atkins et al. (1991) report by saying that it was a perfectly competent piece of work, clear about its assumptions, sufficiently detailed to allow further scrutiny of the data, and far more technically detailed than was typical of the research series in which it was published, which was intended primarily for a readership of crime prevention practitioners. The contentious aspect of the study concerns its starting point and assumptions. Its starting point was to examine lighting effects when "relighting is less well-targeted" (p.3) than in the early studies by Kate Painter, to which it was clearly intended as a counterbalance. The central Atkins assumption, enshrined in the analytic approach of the research, was that the effects of lighting were restricted to the hours of darkness. The key results table from Atkins et al. is reproduced below as Table 1. Leaving for the moment the interpretation of Table 1 offered by Atkins et al., let us instead ask the simpler question: did crime fall after new lighting was installed? It did. There were 7,480 crimes recorded in the year preceding relighting, and 6,399 in the year following, a fall of some 15%. This can be calculated from Table 1 above, but is not to be found in the body of the Atkins report. In Appendix E of the report, an example is provided that could well be actual data, but it is not clear to the reader that this is what the Appendix is intended to convey.⁴

The next question, not addressed at all by Atkins et al. (1991), concerns whether crime elsewhere in the Metropolitan Police district fell during a period matched with that of the Wandsworth relighting. It is impossible to answer this rigorously in retrospect, and in particular one cannot precisely match the Atkins figures for the area as a whole without carrying out supplementary research on at least the

Table 1: Reported Crimes in All Relit Zones One Year Before and One Year After Relighting by Crime Type Groupings

Susceptibility	Before			After				
	Day	Dark	DK	Day	Dark	DK	RPC	SIG
Likely	1419 (27%)	2097 (40%)	1722 (33%)	1166 (27%)	1676 (39%)	1446 (34%)	-2.7%	n.s.
Possible	800 (43%)	522 (28%)	542 (29%)	788 (45%)	518 (30%)	447 (25%)	+0.7%	n.s.
Unlikely	192 (51%)	113 (30%)	73 (19%)	192 (54%)	86 (24%)	80 (22%)	-23.9%	n.s.
Total	2411 (32%)	2732 (37%)	2337 (31%)	2146 (34%)	2280 (36%)	1973 (31%)	-6.3%	n.s.

Notes

Susceptibility refers to the Atkins et al. classification of crime types according to whether they are deemed likely to be responsive to lighting effects.

Day, dark and DK are self-explanatory, indicating whether recorded crimes occurred in the hours of daylight or darkness.

RPC indicates relative percentage change in the dark relative to the day.

SIG indicates statistical reliability of difference (in this case no comparison was statistically reliable).

scale of the original study. This is because the introduction of lighting was phased, so a complex process of area matching would be required.

However, a rough reanalysis is possible, whose results cannot be more than suggestive. The crucial years are 1984-89. An ordinary least squares regression of recorded crime by year in the Metropolitan Police district over the period in question shows an average 0.5% annual rise in recorded crime. If that rise is used as the baseline for the Wandsworth decline, i.e., if one expected Wandsworth crime to have increased over the period in line with the force as a whole, then the Wandsworth reduction in crime observed would have been statistically reliable beyond the .001 level. Based on these assumptions, relighting was associated with a significant fall in crime.

These are back-of-the-envelope calculations, but they do serve to show that the attribution of failure by Atkins et al. (1991) flowed simply from their use of daytime crime as a comparison for crime in darkness. Looking again at the reduction in total crime in Wandsworth, there was an 11% daytime reduction and a 17% reduction during the hours of darkness. In sum, the reason why the Wand-

sworth study does not show a lighting effect is because the daylight reduction in crime provides the baseline. This makes the even greater reduction in darkness fall short of statistical reliability.

Looking again at the Atkins et al. (1991) table, the analysis did not show what is evident with log-linear analysis,⁵ namely that there is a significant day/darkness ⁱⁿ before/after interaction, showing a significant decrease in the proportion of crime committed in the hours of darkness after relighting ($p < .001$), a result certainly worth reporting. Similarly, there is a significant before/ after * crime category interaction ($p < .001$), which is not easily interpretable given that the increase that generates the result is in the "possibly relevant" class of offences. There is no significant three-way interaction term.

There are two aspects of the Atkins et al. (1991) approach that made it likely to result in scepticism:

- (1) A failure to recognise that crime is highly concentrated spatially, and that an overall uprating is a scattergun approach to a series of localised problems.
- (2) The assumption that, because lights only shine at night, they only have an effect at night.

WHEN CRIME IS CONCENTRATED, DIFFUSE CRIME CONTROL IS INEFFICIENT

Various analyses of the British Crime Survey (which captures both reported and unreported crime) show that the 10% of areas suffering **the most crime experience some 25 to 35 times as much crime as the least victimised 10%** (Ellingworth and Pease, unpublished data). Even within the most victimised areas, some individuals and locations suffer disproportionately, and literatures have grown up that detail the phenomena of crime hot spots and repeat victimisation (Pease, 1998; Eck, 1997). This is true for crime as a whole, and for specific crime types such as gun crime (Sherman and Rogan, 1995) and drug dealing (Weisburd et al., 1994). This concentration of crime remains stable over time (Spelman 1995a, 1995b). Failing to reflect crime concentration in the understanding and deployment of crime control measures seems odd, but this is precisely what Atkins et al. (1991) do, in common with many researchers in this area. We already knew from other research that scattergun approaches to crime prevention are inefficient (see Allatt, 1984, for an example and some reasons why). Yet the whole *raison d'être* of the Atkins study was to test the effect of a scattergun approach to lighting as a crime control

measure. Repeatedly in the report, virtue is implicitly (and, to the author, perversely) located by the Atkins study in just such an approach. For example:

Many factors influence the level of actual crime ... of which lighting may be one. The relative importance of these factors is likely to vary between areas so that, although lighting may be a major influence in certain locations, its influence elsewhere may be minimal compared to other factors [p.3].

(Previous) study areas included a narrow walkway or railway tunnel, locations that are widely recognised as potential troublespots and where re-lighting would be most likely to be beneficial. The results could well be different when re-lighting is less well-targeted or applied across larger areas [p.3]

Painter's work is providing useful and consistent information about short-term impacts on particular types of small areas. However, very little is known about longer-term effects or the benefits of re-lighting programmes that are less well-targeted or which are implemented across much wider areas [p.3].

The acknowledgement of localised beneficial effects of lighting on crime is translated in the summary to the conclusion:

There is a widely held belief that the improvement of street lighting will reduce...crime....[but] there is little firm evidence to support these beliefs. This research aims to fill that gap [p. viii).

The central conclusion is expressed thus:

...if street lighting does affect crime, this study should have detected it. The principal conclusion is that no evidence could be found to support the hypothesis that improved street lighting reduces reported crime [p.20].

In the same vein, Malcolm Ramsey's review published as CPU Paper, #29 opined

Even if one accepted each of the three 'blackspot' projects at face value, it would still be highly misleading to draw from them any sweeping conclusions as to the effects of lighting improvements of crime [p. 14].

Thus the prevention of crime by well-targeted deployment of lighting to small areas with big problems seems not to count as lighting-induced crime control. Only untargeted lighting will do! **Painter (1996a:333) comments fairly but perhaps rather acidly:**

The Home Office study suggested that over wide areas, street lighting is unlikely to impact on reported crime. One is tempted to ask why anyone ever thought that it would achieve this.

LIGHTING AND SITUATIONAL CRIME PREVENTION

Before going on to discuss the effects of street lighting that may apply even in the daytime, a brief note is merited on the link between street lighting and the general approach known as situational crime prevention (SCP). The purpose of this slight diversion is to attempt to unlink the literature on street lighting from that background. Had the literature developed within an SCP tradition, the debate would have been less sterile.

SCP involves the modification of environments so that crime involves more effort, more risk and lower rewards (see Pease, 1997, for a summary). It is probably not going too far to say that the best strategy for crime control is now clearly a combination of proven techniques for the reduction of individuals' tendency to commit crime through intervention in childhood, and the manipulation of environments to make that more difficult (see Welsh and Farrington, 1999). In combination, we can hope for a country in which fewer people in pubs want to "glass" each other, and those who do find glasses impossible to use because when they break they leave no sharp edges to use as a weapon.

The reason to be specific about the relationship between lighting and SCP is that the former can gain its authority as a crime prevention measure by association with the latter. This conflation of SCP and lighting is evident in the following pronouncement of Atkins et al. (1991:1):

Does street lighting prevent crime? Making changes to environmental conditions and operational practices to discourage crime has become a well-established part of conventional crime prevention wisdom. These ideas, usually termed 'Situational Crime Prevention' (SCP) underlie a considerable proportion of current crime prevention efforts...Improved street lighting is entirely consistent with SCP concepts; increased visibility

should both reduce opportunities for crime and increase the probability of an offender being caught. But does it really work?

Such an equation of SCP with increased lighting is far too simple. Lighting as a crime prevention tool cannot be justified by reciting the SCP mantra. A defining characteristic of SCP is its close analysis of the situation. There will be circumstances in which extra lighting provides some attackers with an advantage, others with a disadvantage. Try mugging someone in an unlit cave. You don't know what he or she carries that is worth taking, you may not know where the victim is, and if you manage to effect a successful robbery, you don't know which way to go to get out of the cave. In short, a true SCP approach would require a far more detailed and sophisticated analysis of how the situation works for a potential offender and his or her victim. On the basis of the analysis, the situation would then be engineered to:

- (1) increase perceived effort in crime commission,
- (2) increase received risks, and/or
- (3) reduce anticipated rewards.

In these terms, how is street lighting *conventionally* supposed to work to reduce crime? In what follows, for this writer the most plausible (not necessarily the only or most important) account of how lighting might work is discussed, together with its implications. To emphasise, this is not done because this mechanism is a settled fact (the point is made repeatedly that mechanism-based research is conspicuous by its absence), but to illustrate how one could work through the implications of any theoretical position from an SCP standpoint. As an aside, it is noted that the major (albeit now dated) U.S. review explicitly excludes projects that would be among the most effective if the proposed mechanism were important.

Since crime control should not be made to wait 10 years for researchers to make good the omissions of the last decade, practitioners must behave *as if* lighting works by one or another mechanism. Thoughtful practitioners always do this, anyway.

Self-evidently, light is a necessary condition of visual surveillance: if no one notices a crime during daylight, or no one comes to a victim's aid, the light is arguably irrelevant. Lighting is, by this account, the means whereby surveillance becomes achievable in the hours of darkness. However, surveillance — not lighting — is deemed by such reasoning to be an active ingredient, lighting being merely the means by which it becomes possible. Lighting increases surveillance capac-

ity during darkness to daytime levels, by either deterring (by increasing perceived risks) or increasing the probability of apprehension of the offender. Put thus, lighting effects would clearly be contingent on those features of a situation that make surveillance effective or otherwise (see Mayhew, 1981). There is evidence (see, for example, Barker et al., 1993) that offenders are not persuaded that surveillability will be translated into risk for them. The implications of accepting this argument, which will be developed later, are that lighting improvements in pursuit of crime reduction must also seek to translate surveillability into active surveillance or its perception, or be located in areas where such a translation is likely to occur because of the existing community structure.

The contingent nature of lighting effects has one major evaluation consequence, namely, that lighting that is intelligently combined with other measures *probably* stands a better chance of reducing crime. Yet Tien et al. (1979), in the major early review of lighting effects, regarded the combination of lighting with other measures as effectively disqualifying a project evaluation from inclusion on the grounds of its methodological inadequacy. If the Tien et al. view were to prevail, lighting would more often than not be shown to be irrelevant to crime, since measures taken to ensure the salience of lighting improvement would disbar the lighting improvement from consideration.

Some effects of lighting seem to be manifest in daylight, as well as at night. Effects operating in daytime alone, or throughout the 24-hour day, may be the more important.

THE POSSIBLE DAYTIME EFFECTS OF LIGHTING ON CRIME

As noted earlier, Atkins and his colleagues (1991) based their analysis of lighting effects on a set of assumptions about how lighting works to reduce crime. Central to their thinking was the notion that since lights only go on at night, they can have no daytime effect. London-wide data from the same time period suggests that the decline in Wandsworth moved against the citywide trend (see above). Taken at face value, there was a lighting-associated crime decline in Wandsworth, that was more marked during darkness but also present in the daytime. What kind of effect in the daytime might enhanced street lighting have? How might lights work even when they are switched off? A set of varied, but not exhaustive, ways in which lighting may reduce crime appears below.

How Lighting Could Reduce Daytime Crime

- (1) The installation of lighting involves increased daytime surveillance of the streets by workers carrying out the installation, subsequent checks and maintenance of lights, and by the police oversight of traffic or other problems caused by any associated road works.
- (2) New lighting offers a demonstration of the serious intent of local authorities and police to control crime. This may motivate citizens to pass on information about street disorder.
- (3) New lighting equipment visible in daylight offers potential offenders cues about area type, leading them to classify an area as less conducive to easy criminal activity.
- (4) New lighting is a talking point for citizens, leading them to spend more daytime hours on the street and hence in informal surveillance. Insofar as they get to know others in the neighbourhood better, they can recognise strangers in private spaces.
- (5) - Better lighting may increase community pride and cohesiveness, decreasing the motivation to move from an area, and thus reducing the opportunities for burglars presented by "for sale" signs, decreasing recognition of the legitimacy of visitors to the house, etc. (Ellingworth and Pease, 1998).
- (6) If offenders commit crime in both light and darkness, arrests and subsequent processing during darkness may make offenders less available to commit crime during the day.

How Lighting Could Reduce Crime in Darkness, Other Than by Deterrence

- (1) New lighting may increase the time available for maintenance of a front garden and the front of the house, hence increase informal surveillance during darkness.
- (2) Improved lighting may increase pedestrian traffic (and hence informal surveillance), through people walking from their homes when otherwise they would not have gone out, or taken taxis when they could afford to do so (for a discussion of the relationships between pedestrian density and crime, see the papers collected in Clarke, 1996).

- (3) People may be detected in crime more easily. For serious crime, this may remove them from the area for a while. For less serious crime, they may be deterred from offending in an area now perceived as risky.
- (4) The presence of police officers and other authority figures becomes more visible, thus leading to a decision to desist from crime.

How Lighting Could Increase Crime in Daylight

As has often been noted (see, for example Fleming and Burrows, 1986), there are circumstances in which lighting works to an offender's advantage. These might include the following:

- (1) Masquerading as electricity board or contracted workers making checks, burglars by deception could gain entrance to homes.
- (2) Residents developing social lives after dark may find these extending into daylight. For example, attending a midweek evening soccer match may prove so enjoyable that matches are also attended on Saturday afternoons.
- (3) Disorderly activities focused upon a newly illuminated area may spill over into the use of the well-illuminated place as a daylight meeting point.

How Lighting Could Increase Crime in Darkness

- (1) Increased social activity outside the home in the evenings may increase the number of unoccupied homes available for burglary.
- (2) Increased visibility of potential victims allows better judgement of their vulnerability and the value of what they carry.
- (3) Increased visibility allows better judgement of the proximity of "capable guardians," i.e., those people who may observe and intervene in crime.
- (4) Increased illumination of an area reduces visibility from the area into contiguous areas with unenhanced lighting (imagine looking into the street from a well-lit room compared with a dark room). This enhances the possibilities for escape of those offending.

- (5) Increased illumination facilitates activities like drug dealing and other problematic forms of "street life."

Given the range of mechanisms through which lighting could influence crime, it would be unwise and simplistic to make statements of general application. To restate, projects incorporating lighting have been convincingly shown to reduce problems at points of particular crime and disorder. Our aim should be to develop imaginative context-appropriate lighting schemes, and to derive from them a repertoire of tactics. Before developing this point, we will briefly discuss the Dudley Project, the most recent and methodologically sophisticated demonstration of the reduction of crime by the enhancement of street lighting.

THE DUDLEY PROJECT

This initiative (whose evaluation is published as Painter and Farrington, 1997) is probably the most rigorously analysed study of general lighting effects on crime carried out to date. Victimisation surveys (in which people are asked about crimes they have suffered in the previous six months or one year) were employed, covering a 12-month before period and an equivalent 12-month follow-up period. This avoids the primary problem associated with data based on crime reported to the police, namely, that crime suffered is conflated with the tendency to report it to the police (see Painter, 1991). Sample size was decided so as to be confident of detecting a crime reduction of 10% or more. The year before and after lighting enhancement was the time frame for interviews in order to avoid the criticism that the effects were short-term. A comparison area was chosen to establish that the effect was specific to the lighting-enhanced zone, and that crime was apparently not displaced. Detailed checks were made about variables like weather, to minimise the possibility that any effects were attributable to something other than lighting.

The results clearly demonstrated that:

- (1) The incidence of crime in the lighting-enhanced area fell by 41%, in contrast to a 15% reduction in the comparison area.
- (2) The prevalence of crime (i.e., the proportion of people victimised) fell by 23% in the lighting-enhanced area, in contrast to a 3% reduction in the comparison area.
- (3) Incidence and prevalence fell in all crime categories.

- (4) The proportion of people who personally knew a victim of crime fell in the lighting-enhanced area relative to the comparison area.
- (5) People in the lighting-enhanced area became somewhat more satisfied with their area, whereas those in the comparison area became somewhat less satisfied.

Importantly, the decline in daytime crime was similar to the decline of crime after dark. The interpretation of results that the study's authors prefer is in terms of resident confidence, optimism, and community pride, translating itself into informal surveillance. This is of interest because an often overlooked feature of crime control measures is that their effects are almost too speedy, i.e., that the effects exhibit themselves from the commencement of a project rather than at some later point where they may reasonably kick in. To my knowledge, this feature has not been scrutinised formally, although it is evident but unremarked on many projects. For example, a programme of changes to public transport systems in Victoria, Australia had its peak effect on train window breakages within two months of its introduction (see Carr and Spring, 1993). If confidence were to increase with the installation of the first lamppost, the decline in crime would be precipitous.

The Dudley Project establishes, as completely as any single study could, the relevance of lighting to crime reduction. It rises to the challenge presented by the Atkins et al. (1991) study to demonstrate a lighting effect using a more refined design and techniques of analysis. A rearguard action could still be mounted by the disciples of darkness against the results. It would probably make reference to the demand characteristics of the post-illumination interview, where residents may think it churlish to continue to complain about crime when high-quality crime prevention measures had been taken. Also, it may be objected that events may be interpreted as accidents or horseplay by the confident respondent which may be interpreted as crime by the fearful. In this way, the same events occur, but lose their emotional charge and hence are not reported as crime. However tendentious such objections, there will always be the inevitable residuum of uncertainty in the wake of evaluative research. However, the Dudley study is now the benchmark. The comments of Clarke (1997:209) on the project merit quotation:

Until recently, the received wisdom on improved street lighting was that it might reduce fear, but it has little effect on crime...This view is now changing, largely due to the work of

Kate Painter in Britain. In the face of much scepticism...she has produced a series of studies suggesting that the crime prevention benefits of street lighting have been underestimated. Each of her studies has sought to improve on the methodology of earlier ones. ...[T]his study produces clear evidence that crime of all kinds decreased significantly in the re-lit estate compared with the control.

THE STOKE-ON-TRENT STUDY

Painter and Farrington (this volume) extend the work of the Dudley Project using essentially the same methods. The results are substantially the same as those found at Dudley. The following additional points are worth making about the Stoke-on-Trent enterprise.

- (1) Three areas were studied: the area of enhanced lighting, a contiguous area to which crime would have been displaced had displacement occurred, and a comparison area to which displacement would not have been expected. It was found that the incidence of crime declined in the relit area, and in the contiguous (displacement) area, albeit to a lesser extent. This seems to be an example of diffusion of benefits, whereby crime reduction measures taken in one area sometimes spill over into beneficial effects in adjacent areas.
- (2) The cost of prevented crime in the relit area suggested it covered the full capital expenses incurred in lighting enhancement and some £215,000 more, when reductions in relit and adjacent areas were included.
- (3) Unlike the Dudley project, the proportion of crimes committed in darkness fell relative to the comparison area.

The proposed account of the reduction in Stoke was somewhat more complex than that offered for Dudley:

...the effects of improved street lighting on crime operated via two different causal pathways. In the first pathway, improved street lighting caused increased visibility, street use and surveillance after dark, which in turn led to decreased perceived opportunities and rewards of crime and increased perceived risks by potential offenders, which in turn led to decreased crime. The pathway would especially explain a decrease in crime outside after dark. In the second pathway, improved street lighting led to increased community pride,

increased community cohesion and increased informal social control, which deterred potential offenders. This pathway would explain decreases in crime at all times of the day. The operation of both pathways simultaneously would lead to large decreases in crime after dark and to smaller decreases in crime in the light. This prediction, and the hypothesised pathways, are concordant with the quantitative and qualitative results obtained in the Stoke-on-Trent project [Painter and Farrington, this volume, pp. 116-117].

In the face of such a technical tour de force as represented by the combined Dudley and Stoke projects, the debate must surely and belatedly move from the (now settled) question of whether street lighting can reduce crime (it can), to how it can best be used to do so. As recently as 1996, Painter commented "The Home Office study suggested that over wide areas, street lighting is unlikely to impact on reported crime. One is tempted to ask why anyone ever thought that it would achieve this" (1996a:333).

One cannot help but feel that Painter has spent years trying to combat scepticism of the general principle of lighting-induced crime change when she would rather have been detailing how it happens. The Dudley and Stoke projects are impressive demonstrations of the possibility of lighting-induced change, but they are general rather than mechanism-oriented. They are the last word in a debate whose terms were set by others, from Tien et al. (1979) to Atkins et al. (1991).

Painter and Farrington (1997) orient their specification of future research towards the detailing of boundary conditions and dose-response relationships in lighting effects on crime, i.e., give close attention to the circumstances in which lighting works. It is almost with a sense of regret that one perceives how Painter and Farrington were forced by studies such as the Dudley Project to settle the general point, before they and others could move on to these crucial questions. What if conditions in Dudley and Stoke had lain outside the boundaries in which the general improvement of lighting showed crime reduction benefits? It would have put back for a long time the application of focused lighting changes. Yet Painter's early research and some other work had shown that targeted lighting of small, crime-prone areas was beneficial. That body of research would, as a basis to work from in crime control, probably have been disregarded.

One aspect of the Dudley and Stoke studies to which attention is not drawn in their written accounts is that of crime concentration. Earlier in this report, the highly concentrated nature of crime victimi-

sation was noted, together with the implications this must have for lighting strategies. Is there any clue from these studies about the effect of lighting on crime concentration in the areas covered?

The two preferred measures of crime used by Painter and Farrington (1997) — and almost everyone else — are prevalence and incidence. Prevalence counts the number of people victimised in relation to the population. Incidence counts the number of crime events in relation to the population. Thus, in a village of 100 people, if 20 people are victimised twice each, the prevalence is 0.2 ($20/100$), and the incidence is 0.4 ($(20 \times 2)/100$). There is a third measure, concentration, which relates to the number of victimisations per victim, measured as incidence/prevalence ($0.4/0.2$). The reason why this is both theoretically and practically important is that one aim of crime reduction is to reduce the impact of crime on those most heavily victimised. Measuring concentration in the way described above is crude. More sophisticated methods are available, but cannot be applied to the Dudley and Stoke data available to the present writer. However, one can ask whether the crime reduction achieved through lighting serves to help the most victimised more than the less victimised, i.e., does it reduce crime concentration? One would hypothesise that it should. Insofar as the darkest areas offer the richest crime opportunities during the hours of darkness, those are the areas on which crime in darkness would be concentrated, and also in which the introduction of lighting would have its greatest proportional impact.

In recognition of the crudity of the measures at hand, Table 2 below shows the change of concentration measures for total crime in Dudley and Stoke in relit, adjacent and comparison areas. It will be seen that in both towns, the lighting-enhanced area experienced the greatest reduction in crime concentration. In Stoke, the reduction in concentration was limited to the lighting-enhanced area, i.e., the "diffusion of benefit" effect did not extend to the reduction in crime concentration in the adjacent area. This is important because it *suggests* that diffusion of benefits does not extend to the benefit of reduced concentration of victimisation on certain victims. However, the central message of Table 2 is that lighting changes confer the most help on those most frequently victimised by crime. The benefits of street lighting for the most heavily victimised are consistent with the early Painter work, which shows the effects of lighting in crime hot spots.

Table 2: Changes in Crime Concentration, Stoke and Dudley Study Areas

Area	Change in crime concentration
Dudley lighting-enhanced area	-23%
Dudley comparison area	-13%
Stoke lighting-enhanced area	-33%
Stoke contiguous (displacement) area	- 9%
Stoke comparison area	-13%

WHAT NEXT?

Given that the capacity of street lighting to influence crime has now been satisfactorily settled, how should policy move forward to reflect this, and how should formal research and practical experience be combined most helpfully? The writer's *personal* view is detailed below.

Movement is necessary on two fronts:

- the incorporation of lighting issues in local plans under the Crime and Disorder Act 1998; and
- the eschewal of a formulaic approach to lighting as crime control, and the gathering, dissemination and evaluation of case studies of innovative use of lighting and other crime control measures.

The Crime and Disorder Act 1998

In the short term, it is suggested that the Home Office advise local authorities and police of the desirability of having lighting expertise at least available to community safety organisers, and possibly actually sitting on "responsible authority" groups locally.

In the middle term, it is suggested that crime audits and resulting plans be scrutinised in terms of the presence or absence in them of the whole repertoire of crime control techniques, including the deployment of lighting. A review of such audits and plans should then be available to inform the second three-year planning cycle envisaged

under the Crime and Disorder Act 1998. Local community safety organisers would not be averse to such a process, since the first round, now being completed, can politely be described as approximate! Incorporated in this process should be the dissemination of innovative schemes currently operating elsewhere, including those involving lighting.

In the longer term, the Virtual Reality capacity of local authorities should be enhanced to the point at which illumination and other effects can be modeled alongside crime and disorder data. This will allow a tool for community consultation and provide the basis for a reasoned choice about lighting and other priorities.

LITERAL AND LATERAL THINKING ABOUT LIGHTING AND CRIME

Bathing an area in light to reduce crime in parts of it may be as crude as bathing a body in radiation to shrink a tumour in one organ. The changes in crime concentration in Dudley and Stoke-on-Trent suggest that lighting may have its greatest effect in small areas. Economy and the avoidance of light pollution, along with the need to optimise crime control efforts, argue for a more reasoned and possibly more selective approach to lighting. There is a trade-off here. Clearly one should not stigmatise a localised hot spot by supplementing lighting *only* there. Likewise, one should not relight large areas with little crime on the grounds of crime reduction. One should think of areal units that are large enough not to stigmatise, but small enough not to protect areas that do not need such protection.

Concretely, what is recommended is a trawl for (and stimulation into existence, if necessary, of) innovative targeted uses of lighting and other crime reduction techniques, to be fed into the second three-year cycle of local crime audits and plans instituted by the Crime and Disorder Act 1998 and due in 2001. This trawl may allow limited retrospective analysis of effects, and some resources should be put into such evaluation. However, the purpose is hypothesis generation about the diverse ways in which light might work, not hypothesis testing about the effects of their installation. In what areas may innovative thinking about lighting effects be particularly welcome?

Change and Stasis in Lighting

There is a noteworthy contrast between the use of street lighting for crime control on the one hand, and the private market in security lighting on the other. Specifically, street lighting is simply on during the hours of darkness. Security lighting comes on only when a sensor detects movement. The reason for street lighting to be generally constant is clear.

... in the United Kingdom, central government funds for promoting street lighting projects comes under the jurisdiction of the Department of Transport and the Department of the Environment rather than the Home Office, which has most interest in crime prevention. This arrangement tends to marginalise the crime-related aspects of street lighting projects. Street lighting programmes are funded out of the highway budgets of local authorities, primarily on the basis of traffic safety and traffic flow [Painter 1996a:318].

The particular virtues of lighting change rather than lighting *per se* in crime reduction is clear. Change elicits attention, hence (potentially) surveillance. Is there scope on streets and in other public areas for movement-triggered lighting? Clearly there is. Multistorey car parks typically have small areas in which crime is more frequent. Lighting triggered by the movements of motorists leaving or returning to their cars, and those engaged in car crime, may be more effective attention-getters than constant enhanced lighting.

Movement-triggered change may be from darkness to light, or from light to darkness. Are there circumstances in which the sudden removal of light may be helpful? Imagine commercial robbery in which movement triggers an alarm and makes internal lights inoperable, thus making the choice of things to take, and leaving, more difficult. This may or may not be undesirable for staff and legitimate customers. In a bank, for example, would plunging the staff area into darkness and increasing the illumination of the customer area be feasible? It would make staff invisible to the robbers, yet would not put customers in a more difficult position than they would otherwise be in.

It may be apparent, after full discussion, that movement-triggered lights (or darkness) are of limited application in crime control in public spaces. However, the fact that locations where lighting is marketed for security purposes are triggered by change suggests that this may not be the case. What is advocated is the exploration of a variety of lighting styles in the public arena. As with the suggestions made

later, it may be that there are projects already under way that use lighting in this way. If so, all that needs to be done is to create a trawl for local studies, some evaluation, and the publication of the most promising research.

Lighting Plus...

If we can discard the view that a crime reduction measure must be administered alone to be evaluated, and encourage a substitute view that intelligent combinations should be evaluated, we can revisit the literature to find *sparse and as yet inconclusive evidence* that lighting improvements may be particularly valuable in combination with other measures, such as increases in police patrol (Wheeler 1967; Tyrpak 1975), commercial security surveys (Griswold 1984, 1992), and rearrangement of available space (Poyner and Webb 1992). An obvious combination would be movement-triggered lighting and closed circuit television (CCTV) surveillance. If movement-triggered lighting were an overt symbol of CCTV surveillance, with posters advertising the fact, that would constitute a visible token of being watched and recorded. As noted by Baldrey and Painter (1998), lighting enhancement often accompanies CCTV installation, so there may already be the makings of a natural experiment to determine whether the measures combined seem particularly successful.

Lighting Change and Gradients

An intriguing study links day-to-day variation in illumination levels with fear of crime (Vrij and Winkel, 1991). It is intriguing because it focuses on the variation of illumination, rather than its absolute level, as a tool.

Insofar as it is technically possible, we can think of:

- The effects of day-to-day variations in lighting in crime-prone areas. There is evidence (Kelling and Coles, 1996; Pease, 1998) that change in itself may reduce crime. The original and highly influential "broken windows" hypothesis of Kelling and Wilson (1982) suggests that the absence of change (instantially the non-repair of a building's broken windows) suggests area indifference to crime, and, hence, its probable recurrence. Could more subtle changes, e.g., of lighting, have crime-reductive effects?

- Brighter lighting is often installed at major road intersections. Could illumination levels be increased locally and routinely in the wake of a rash of recorded crimes? Alternatively, could behaviour be shaped by gradients of illumination that subtly move people away from where they could cause disorder, e.g., by having slightly higher illumination levels in those sections of the street in which fewest problems would result?⁶
- Could street lighting be integrated with the 999 (911) telephone system, so that street illumination increases immediately following an emergency call, hopefully alerting people living around to look out or help more actively?

If the reconsideration of the lighting-crime nexus helps to liberate the debate from the sterile "does it work or doesn't it?" to the more productive "how can I flexibly and imaginatively incorporate lighting in crime reduction strategy and tactics?" it will have been worth the effort. Lighting is only one element in the armoury of situational reduction, and does not merit any special consideration because of its recent neglect. However, it does deserve consideration as one more tool, to be used with intelligence and possibly in combination with other methods, in the perpetual "arms race" between the resourceful criminal and the resourceful preventer of crime.



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NOTES

1. No offense is intended to those yet to be persuaded of lighting effects on crime. I just couldn't think of a more succinct way of describing the protagonists in the debate.

2. Sometimes the results of preconceptions are amusing. Demuth (1989) asked Brighton citizens about areas they avoided, and found that only 9% cited poor lighting as a reason for avoidance. Few of the streets avoided were also regarded as being poorly lit. This is like asking those who avoid soccer matches about the quality of lighting in soccer stadia. If you avoid the stadium, how are you supposed to make a sensible judgement about the quality of its illumination?
3. This is not to say that believers are indifferent as to mechanism, merely that research has not yet been carried out to elaborate such mechanisms.
4. Painter (1996a) seems to think the example reflects real data, but this writer thinks they do not since the reductions there illustrated are somewhat different from those calculable from Table 2 of the Atkins report.
5. Using Glim, with Poisson error and log link, probabilities derived from G^2 with appropriate df.
6. Please allow the writer one moment of nostalgia. Forty years ago he was a "youth causing annoyance," as the police report would have it, in an estate in North Cheshire. The cricket stumps were the foot of a lamp-post, which doubled as one of the goalposts during winter. One lady rang the police about us often. If the lamppost three further down the street had been brighter, we would have gone there and either annoyed no one or spread the misery of our presence along the street. This would also have made the chances of our survival to adulthood greater, given the closeness of a road turning.