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A Critical Review of Street Lighting, Crime and the Fear of Crime in the British City.

Abstract
The government has recently made £300 million available to help local authorities to modernise their street lighting. In consideration of such future funding, this paper reviews the relationship between lighting and crime, explores the current theoretical explanations and discusses the limitations of the existing BS 5489 lighting standards as they relate to crime reduction.

British street lighting standards rely largely upon official recorded crime statistics as the preferred measure of crime and crucially, fear of crime maps have been shown to differ markedly from the reality suggested by recorded crime statistics (Brantingham *et al.*, 1977; Vrij and Winkel, 1991). The implications of utilising the current classification of streets according to levels of recorded crime and levels of pedestrian and traffic flows to determine acceptable lighting levels, are presented. In the light of recent research on crime and street lighting, local authorities might usefully critically review lighting levels following the Crime and Disorder Act 1998. Acknowledging the emergence of the 24-hour city the policy implications for improving the crime reduction potential of street lighting is discussed.

Keywords: Street Lighting, British City, Crime, Fear of Crime, Policy Implications.

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Introduction

It has been estimated that half of all recorded crime occurs after dark (Painter, 1994) and that "fear of crime is experienced disproportionately after … dark" (Samuel, 2001, p95). Fear in the after dark environment may represent a rational evolutionary strategy against the night's permissiveness. However, as Britain moves ever-closer to the 24 hour city "being out-and-about at night is an anthropogenic addition to nature's ways, and it is now thus a responsibility of environmental designers to ensure that this can happen in safety and without trepidation" (Samuel, 2001, p95). Recent reviews of the crime reduction potential of improved street lighting (Pease, 1999; Farrington and Welsh, 2002) intimate that recorded crime can be reduced. However, the minimum street lighting standards commonly attained in such improvement initiatives (BS 5489) may not adequately reflect the actuality of crime, fear of crime or user perceptions of lighting quality. Indeed, Lynch (1976) observed how activities and perceptions of different component parts of a city vary throughout the course of a day. The 'evaluative image' of the city (Nasar, 1998) will certainly be affected by levels of street lighting after dark.

This paper reviews the lighting and crime research debate, discusses the limitations of BS 5489 lighting standards for crime reduction and suggests how the crime reduction potential of street lighting might usefully be enhanced. Furthermore, the lack of any explicit reference to lighting in government policy statements and planning policy guidance notes provides further impetus for such a review. Significantly, the government has recently made £300 million available to help local authorities to modernise their street lighting, with an annual bidding round scheduled to begin in March 2003 (Institute of Lighting Engineers, 2002a).

Warr (1990) notes that research has shown that many individuals avoid leaving home after dark (Warr, 1985; Du Bow *et al.* 1979). In a study in Australia, 10% of residents studied stated that they never go out after dark and 43% felt unsafe going out after dark (Ian Haywood Partnership, 1997). According to the British Crime Survey (Kershaw *et al.*, 2001) 30% of respondents stated that they never walked alone in their area after dark. However, this figure varies in relation to a range of criteria, including area type (inner city, urban and rural), region, gender, age, housing tenure and social class.
Clearly, fear of victimisation is experienced disproportionately after dark and Samuels (2001, p97)) states "from an *environmental-design* point of view, night domains need to be extremely carefully illuminated, as must the paths and routes to them and between them and public transport nodes"

A Review of the Literature

Modern interest in the relationship between crime and lighting has its origins in the USA in the 1960s, where major lighting improvement programmes were implemented to combat the rise in street crime (Painter and Farrington, 1997). Many cities began major street lighting programmes to reduce crime and initial results were encouraging (Wright *et al.*, 1974). Berla (1965) reviewed programmes in six cities and found that improvements caused substantial reductions in recorded crime. Other research found that lighting was

especially effective when introduced along with increased police patrols in New York (Wheeler, 1967) and Newark (Tyrpak, 1975). Hartley (1974) demonstrated that street crime reduced as a result of improved street lighting. The proliferation of such projects resulted in the decision by the Law Enforcement Assistance Agency to fund a review of these 'positive' results (Tien *et al*., 1979). Of 103 studies, only 15 were considered sufficiently rigorous for evaluation and the review of these studies found that the results were generally inconclusive. The review suggested that improvements be made to the research design of such studies and suggested that alternative measures for crime should be utilised (victim surveys, self-reporting and systematic observation). Crucially, Tien *et al.*, (1979) observed that street lighting could lead to increases in the reporting of crime and that therefore, the effects of lighting should not be measured relying solely on official statistics. Farrington and Welsh (2002) argue that the review should have stimulated more studies but was interpreted as demonstrating that lighting had no obvious effect on levels of crime and research in the USA declined.

In the UK there was little research in this field until the late 1980s and two reviews criticised the lack of research (Mayhew *et al*., 1976 and Fleming and Burrows, 1986). A resurgence of interest occurred in 1988 (Painter and Farrington, 1997).

In lighting studies of Hammersmith and Fulham (Painter 1991a) and the North West of England (Painter 1991b) reductions in crime and disorder were reported. A Home Office funded study (Atkins *et al*., 1991) conducted in Wandsworth found no effect on crime, as did a review by Ramsay and Newton (1991). The latter did suggest, "improvements to street lighting can help to reduce the public's fear of crime, but … they make less of a difference to the prevailing level of crime that many people would expect" (Ramsay, 1991, p24). Other studies in Cardiff (Herbert and Hyde, 1991), Hull (Davidson and Goodey, 1991), Leeds (Burden and Murphy, 1991) and Strathclyde (Ditton *et al*, 1993) produced inconclusive findings using "before" and "after" comparisons but failed to provide a control area (Painter and Farrington, 1997).
Methodological flaws have raised questions about the validity of many of these exploratory studies (Painter and Farrington, 1997).

However, researchers began to collect and analyse limited amounts of original data on crime for their analysis of the relationship between lighting, crime and the fear of crime. Bainbridge and Painter (1993) studied improved lighting in Birmingham's inner city, which despite the collection and analysis of such additional social survey data, also proved inconclusive. The survey measured level of crime against households declined but there was no change in recorded crimes against pedestrians – although pedestrian street use had increased. However, acknowledging that pedestrian flows in their study had been found to have increased this strongly suggests that street level crime rates may well have also declined. Poyner (1993), found lighting was an effective general crime reduction measure and La Vigne (1994) demonstrated the effectiveness of improved lighting on petrol station forecourts. Painter (1994) studied poorly-lit streets in London's Edmonton and Tower Hamlets finding that after lighting improvements were implemented, crime, disorder and fear of crime declined and pedestrian street use increased.

Furthermore, a study by Painter and Farrington (1997), which utilised experimental and control areas, also showed reductions in crime and an increase in pedestrian street use.

They concluded "in the experimental area, there was a substantial and significant decrease in the incidence of all categories of crime after the improved street lighting" (Painter and Farrington, 1997, p221).

However, Pease (1998) has argued that the last fifteen years has witnessed the emergence of the view that street lighting does not reduce crime, views which are attributed to the Home Office research papers 28 and 29 (Ramsey, 1991; Atkins *et al.*, 1991) which have been taken as, in some sense, an official position. His review was conducted to evaluate the effect of lighting on crime and produced several insights.

- Specifically targeted initiatives work best in high crime areas. Pease (1998, p2) argues that "Precisely targeted increases in street lighting generally have crime reduction consequences; i.e. the improvement of lighting in very specific locations which are the scenes of repeated crime generally reduce crime at least in the short term".

- More general increases in street lighting seem to have limited crime reduction potential. Studies evaluated in the USA were less positive than those conducted in the UK.

- Even untargeted increases in crime reduction generally make residents less fearful of crime and more confident of their own safety after dark.

- Where street lighting improvements are successful, crime reduction occurs in the day as well as after dark – suggesting that the effects of lighting are more than just improved surveillance. Pease (1998) argues that changes in street use, enhanced community pride and a sense of ownership are the probable explanation. The review also suggests lighting effects are most significant in chronically victimised areas.

For Pease (1999, p48), the case is proven; "reading the research and evidence now leads to the inescapable conclusion that street lighting can help in crime control". However, looking to the future, Pease (1998, p2) suggests that action is required on two fronts. Firstly, he argues that street lighting should be considered as one element in local strategies under the Crime and Disorder Act 1998 in tandem with other physical and social improvements. He observes how funds for promoting street lighting derive from the Department of Transport and Department of the Environment rather than the Home Office (which has the main interest in crime prevention). For Painter (1996, p318) "this arrangement tends to marginalise the crime-related aspects of street lighting projects …[which are] …funded out of the highway budgets of local authorities, primarily on the basis of traffic safety and traffic flows". Secondly he calls for "the gathering, dissemination and evaluation of case studies of innovative use of lighting and other crime control measures" (Pease, 1999, p68), rather than promoting a formulaic approach.

The most recent review of lighting and crime research re-examined the most robust studies conducted in the UK and the USA (Farrington and Welsh, 2002). This systematic review found that improved street lighting reduced recorded crime overall by 7% in the eight American studies and 30% in the five UK studies, and reductions in recorded crime were also demonstrated during they day – suggesting that street lighting is more likely to have an

effect by increasing community pride and informal social control rather than by improving surveillance opportunities. Across all the studies the crime reduction effect was 20%. The UK studies included Poyner (1991), Shaftoe (1994), Poyner and Webb (1997), Painter and Farrington (1997; 2001a) and Painter and Farrington (1999b). However, other measures of crime, such as victimisation surveys, were not explicitly discussed in the report and therefore the robustness of the findings is questionable. Studies have also revealed that the financial benefits (based upon government estimates of the financial costs of various crimes) of improved street lighting schemes far outweighed the additional financial costs (Painter and Farrington, 2001b) In the light of recent research Pease (1998, p2) states "our aim should now be to use context-appropriate lighting schemes as part of a full repertoire of crime reduction tactics".

Crucially, improved lighting studies are officially guided by the existing British Standards for street lighting (BS 5489). A local authority does not have any duty to provide street lighting (Institute of Lighting Engineers, 2002b) but, once provided, it does have a duty to maintain the system in a safe condition as determined by BS 5489. BS 5489 utilises recorded crime statistics as the dominant measure for crime and, alongside levels of pedestrian street use and traffic flows, this sets minimum lighting levels for different areas. More recent studies have utilised victim surveys (Painter, 1994; Painter, 1996; Painter and Farrington, 1997; Painter and Farrington, 1999a) but significantly they are also designed to improve the lighting in accordance with BS 5489 criteria for the lighting of different urban areas.

Theoretical Explanations

In their recent systematic review of the subject, Farrington and Welsh (2002) discuss various theories that argue why improved lighting may reduce crime. Firstly, improved street lighting provides increased surveillance of potential offenders (by improving visibility and encouraging more 'eyes on the street' in the way of increased activity). Such ideas are supported by those advocating situational crime prevention (e.g. Clarke, 1995), who argues that physical modifications (including lighting) can act to reduce opportunities and rewards while increasing the risk of being seen and potentially apprehended. The emerging field of CPTED (Crime Prevention Through Environmental Design) (e.g. Newman, 1973; Crowe, 2000) similarly demonstrates that the design and management of the built environment can affect both crime and the fear of crime.

The informal social control model (Jacobs, 1961; Angel, 1968) reveals that increased surveillance can act to enhance street activity thereby increasing the number of potential witnesses and informal social control. The change in routine activity patterns increases the flow of potential capable guardians (Cohen and Felson, 1979) – offenders are more recognisable and may be more likely to be seen and interrupted and risks for offenders are thereby increased (Mayhew, 1979). For the potential victim risk and fear of crime are therefore reduced. Improved visibility and increased pedestrian flows interact to heighten informal surveillance opportunities (Newman, 1973; Bennett and Wright, 1984).

Farrington and Welsh (2002, p30) argue, "a core assumption of both opportunity and informal social control models of prevention is that criminal opportunities and risks are influenced by environmental conditions in interaction with resident and offender characteristics". However, lighting is not a physical barrier to crime, rather "it can act as a

catalysts to stimulate crime reduction through a change in the perceptions, attitudes and behaviours of residents and potential offenders" (ibid.).

Additionally, recent research reveals that improved street lighting signals that there is increased community investment and that an area is improving, resulting in an increase in community pride, community cohesiveness and informal social control. Investments in neighbourhood conditions (Taub *et al*., 1984; Gottfredson, 1986; Wilson and Kelling, 1982; Skogan, 1990) emphasise the importance in terms of the strengthening of community dynamics and informal social control. Physical improvements combined with changes in social dynamics may act as a psychological deterrent. 'Image' improvements may suggest to offenders that social control, order and surveillance have increased (Taylor and Gottfredson, 1986). Perceived heightened risk can deter existing local offenders and deter mobile offenders from entering (Wilson and Kelling, 1982). For Farrington and Welsh (2002, p4), lighting "provides a highly noticeable sign that local authorities are investing in the fabric of the area"

Finally, fear of crime and studies of the perception of crime after dark suggest that lighting improves the environment and alters users' perceptions. People sense that a well-lit area is simply less dangerous than one that is dark (Warr, 1990). The improved, more 'positive' environment is therefore, shared by residents and pedestrians and actual and perceived risks may be re-evaluated and usage thereby increases.

How Improved Lighting Can Reduce Crime

Pease (1999) provides a summary of how improved street lighting can reduce crime in the daytime.

1. The installation of lighting involves increased daytime surveillance of the streets by those installing, maintaining and monitoring lighting and by the police who might oversee traffic or other problems associated with the works.
2. New lighting demonstrates the intent of local authorities and police to control crime and may encourage citizens to report incidents.
3. The installation of new lighting may signify to potential offenders that the area is of the type that may be less vulnerable.
4. Citizens may well discuss the new lighting equipment as a talking point and, spend more daytime hours on the street, thus providing more informal surveillance and better recognition of offenders.
5. Community pride and community cohesion may be increased thereby decreasing motivations to move away, thus reducing the opportunities for burglars associated with "for sale" signs, decreasing also the legitimacy of outsiders visiting property (Ellingworth and Pease, 1998).
6. Offenders who commit crimes in the daytime and after dark may be unavailable to commit crimes during the day as a result of increased arrests.

Pease (1999) also suggests how lighting can reduce crime after dark, in ways other than by deterrence.

1. New lighting may increase the time available for maintenance of front gardens and the front of the dwelling thereby increasing informal surveillance after dark.

2. Lighting improvements may lead to increases in pedestrian movements (and therefore in levels of informal surveillance) when some people might previously have avoided going outside.
3. Potential offenders may be more easily detected in areas with improved street lighting.
4. The presence of police officers and other authority figures becomes more visible, potentially reducing offending.

How Improved Lighting Might Facilitate Crime

As has previously been noted (e.g. Fleming and Burrows, 1986) improved lighting might facilitate crime in the daytime, and Pease (1999) summarises below;

1. Burglars masquerading as officials or contracted workers carrying out checks may attempt to gain access to properties via deception.
2. Residents developing social lives after dark may find that these extend into the daytime / weekends – providing opportunities in the form of properties that are left unoccupied.
3. Disorderly activities focused upon newly lit areas may spill over into the well-illuminated area as a daytime meeting place.

Finally, Pease (1999) suggests how crime might be facilitated after dark as a result of improved lighting.

1. Increased social activity outside the home in the evening may lead to an increase in the number of unoccupied properties available for burglary.
2. The increased visibility of potential victims facilitates better assessments of their vulnerability and the value of their possessions.
3. Increased surveillance opportunities provided by improved lighting makes more obvious the proximity of 'capable guardians' and those who may observe and intervene.
4. Improved lighting in one area reduces visibility from the area into adjacent areas without enhanced lighting and increases opportunities for egress.
5. Increased illumination facilitates some activities such as drug dealing and other problematic forms of 'street life'.

Farrington and Welsh (2002, p5) acknowledge that lighting may in some instances facilitate crime, and comment that "the effects of improved street lighting are likely to vary in different conditions. In particular, they are likely to be greater if the lighting is poor and if the improvement in lighting is considerable".

Problems of Measurement: Recorded Crime Statistics

Although the positive effects of improved street lighting on crime are now widely accepted, many lighting studies continue to use official statistics as the preferred measure for crime. Indeed, the British Crime Survey (Kershaw *et al*., 2001) estimates that the incidence of certain crimes may be four times higher than the recorded crime data suggests. Since local and national official crime statistics are used to map criminality and allocate resources to lighting and other crime prevention initiatives, it is therefore essential that more meaningful crime data be collected. Indeed, some researchers have called for more precise, site-specific data (Reppetto, 1974; Cozens *et al*., 2002). Geographical Information Systems (GIS) mapping of recorded crime statistics and socio-economic and demographic information has developed considerably in recent years and promises much for the future. A GIS crime map would therefore illustrate the geographical distribution of crime based on official recorded

crime statistics. Such data, however, does not adequately reflect the reality of crime (Kershaw *et al*., 2001; Maguire 1997; Scott, 1990, Wong, 1997) at the localised neighbourhood level. Furthermore, fear of crime has emerged in recent years as being as important an issue as crime itself, and the use of recorded crime statistics as the major underpinning for research and policy has obvious limitations.

Crime statistics used to guide the implementation of CPTED initiatives such as lighting improvements are also open to criticism in themselves. The reportability and recordability of incidents of crime may well result in persistent under-estimations, and the 'dark figure' of crime (Scott, 1990; Maguire, 1997) may clearly be substantial. Recent procedural changes for counting and classifying crime have themselves resulted in a 14% increase in recorded crime rates in the U.K (Home Office, 2000, p26). Areal differences in police force resources, management and operational priorities can also further reduce the effectiveness and usefulness of geographical comparisons of recorded crime statistics (Farrington and Dowds, 1985).

The development of the victim survey in America the 1960's encouraged such trends elsewhere. The British Crime Survey (BCS), initiated in 1982, has attempted to provide a more meaningful measure for crime, and consistently reports substantially more incidents of criminality than the published Home Office statistics (Mirrlees-Black *et al.*, 1998). However, since the BCS is based upon a sample population, the utility of this data is restricted and may prove inadequate for guiding lighting initiatives. Furthermore, a location experiencing high levels of fear of crime may not receive appropriate police attention, when, according to recorded crime statistics, incidents of crime are relatively low. Indeed, Brantingham *et al*, (1977) employed both recorded crime statistics and mental maps of the fear of crime and found mismatches to be a common occurrence. Vrij and Winkel (1991) analysed unsafe locations and observed, "many places perceived as unsafe were never examined because in reality they are not unsafe" (Vrij and Winkel. P204). Indeed, Harries (2000) states, "…the 'fear surface' … in a city is an intriguing mystery" (Harries, p27). Vrij and Winkel (1991) conclude, "research that defines unsafe locations primarily on the basis of crime statistics is therefore incomplete" (Vrij and Winkel, p214). The growth of research into fear of crime has been significant (Hale, 1996) although for Harries (2000) "fear is not usually accorded the attention it deserves" (Harries, p28).

Tien *et al.*, (1979) argued that recorded crime rates should not be utilised to measure the impact of lighting on crime since improved lighting could lead to increased reporting. Indeed, Painter (1994, p119) has stated "it is well-established that, with few exceptions, surveys provide a more accurate barometer of crime and disorder than official statistics". Samuels (2001, p95) argues succinctly; "…in crime rates drawn from police and court data alike, phenomenological validity is lost i.e. reported / recorded rates are not representative of the reality on the ground, on their own".

Problems of Measurement: Street Lighting Standards (BS 5489)

In terms of guidance for lighting standards, there are no specific planning policy guidance (PPGs) for lighting the British city after dark per se, although lighting is implicitly referred to in several PPGs. Furthermore, the government's guidance 'Planning Out Crime' circular 5/94 (DOE and Welsh Office, 1994, p3) does not make any explicit reference to lighting levels. It states that Local Plans and Part 2 Development Plans should aim to "reassure the

public by making crime more difficult to commit, increase the risk of detection and provide people with a safer more secure environment" by using the "…deterrent effects of good design, layout and lighting". The guidance does recommend the 'Secured By Design ' (SBD).

However, BS 5489 *is* recommended by the 'Secured By Design' and 'Secured Car Parks' schemes as well as in the government's 'Places, Streets and Movement. A Companion Guide to Design Bulletin 32: Residential Roads and Footpaths' (DETR, 1998). The 'Guide to General Principles' set out in the British Standard for Road Lighting BS 5489-1 (BSI, 1992a) states that "…while effective lighting for traffic and pedestrian safety is essential…amenity and environmental requirements should always be given full consideration and there should be an appreciation of the assistance lighting can afford crime prevention". Part 3 Code of Practice for Lighting for Subsidiary Roads and Associated Pedestrian Areas BS 5489-3 (BSI, 1992b, p4) sets out lighting requirements and areas are classified according to pedestrian street use, crime risk and traffic use; as displayed in Table 1.

Table 1. Lighting Requirement for Subsidiary Roads and Associated Pedestrian Areas

a) Category 3/1

Roads where night-time public use is likely to be high (this may be associated with amenities such as clubs, shopping facilities, public houses, old people's homes etc.); ***or*** the crime risk(1) is likely to be high; ***or*** traffic usage is likely to be high.

b) Category 3/2

Roads that do not fall into category 3/1 and where night-time public use is likely to be moderate (this may also be associated with amenities such as clubs, shopping facilities, public houses, old people's homes etc.); ***or*** the crime risk(1) is average to low; ***or*** traffic usage is of a level equivalent to that of a housing estate access road.

c) Category 3/3

Roads where night-time public use is minor and solely associated with the adjacent properties; ***and*** the crime risk(1) is very low; ***and*** traffic usage is of a level equivalent to that of a residential road.

(1) Assistance in deciding on the crime risk, i.e. high, moderate or low, should be obtained from the local crime prevention officer.

Source: BSI (1992b, p4).

Clearly, the designation of areas as low, medium or high crime risk (even with the assistance of a crime prevention officer) is highly problematic and arguably provides only a partial understanding of the actuality of crime in the area. The aggregation of statistics could also further reduce the validity of such an approach in that the police areas used would provide an average for that area – ignoring local variations that are certain to exist. Further problems are related to lighting schemes, which could potentially overlap several of the police statistical areas making categorisation more problematic. Table 2 lists the minimum and average lux levels for the area categories. Simply, 'lux' is the unit of illumination, a scientific measure for light equal to one lumen per square metre. For the ordinary citizen, twilight is typically 1 lux and homes are commonly illuminated to 150-300 lux, while direct sunlight is around 100,000 lux. When the eye has become adapted to

low light it is just possible to detect an approaching individual, having a good contrast with the background, with light levels as low as 1 lux. Much higher lux levels are required in order to recognise an individual's features, and the time taken to adapt to low light conditions can vary from a few minutes for young people, to more than twenty minutes for the elderly.

Table 2. Lighting Requirements for Subsidiary Roads and Associated Pedestrian Areas

Category	Area Characteristics	Minimum lux Levels	Average Lux Levels
3/1	- 'high' pedestrian street use - ***or*** high crime risk(1) - ***or*** high traffic flows	**5**	**10**
3/2	- 'moderate' pedestrian street use - ***or*** 'average' to 'low' crime risk(1) - ***or*** traffic use is equivalent to a housing estate access road	**2**	**6**
3/3	- 'little' pedestrian street use - ***and*** 'very low' crime risk(1) - ***and*** traffic usage is equivalent to a residential road	**1**	**3.5**

(1) Assistance in deciding on the crime risk, i.e. high, moderate or low, should be obtained from the local crime prevention officer.

Source: BSI (1992b, p4).

The categorisation of subsidiary roads and associated pedestrian areas based upon such criteria may potentially seriously jeopardise community safety in locations where, according to official crime statistics, crime is low. In such places the suggested minimum standards for lighting levels are therefore also lower. Hypothetically, such an approach may mean that brightly lit 3/1 areas (with high assessed crime risk or pedestrian or traffic flows) may exhibit average lighting levels of 10 lux are located adjacent to less well lit 3/3 areas (with low assessed crime risk and low pedestrian and traffic flows) that may exhibit only the minimum level of 1 lux. Further standards (BS 5489-9) also exist for urban centres and public amenity areas (BSI, 1996). Different levels of lighting are recommended for the city or town centre, the suburban shopping street and for the village centre, according to whether the areas are primarily vehicular, mixed vehicular and pedestrian areas or wholly pedestrian (Table 3).

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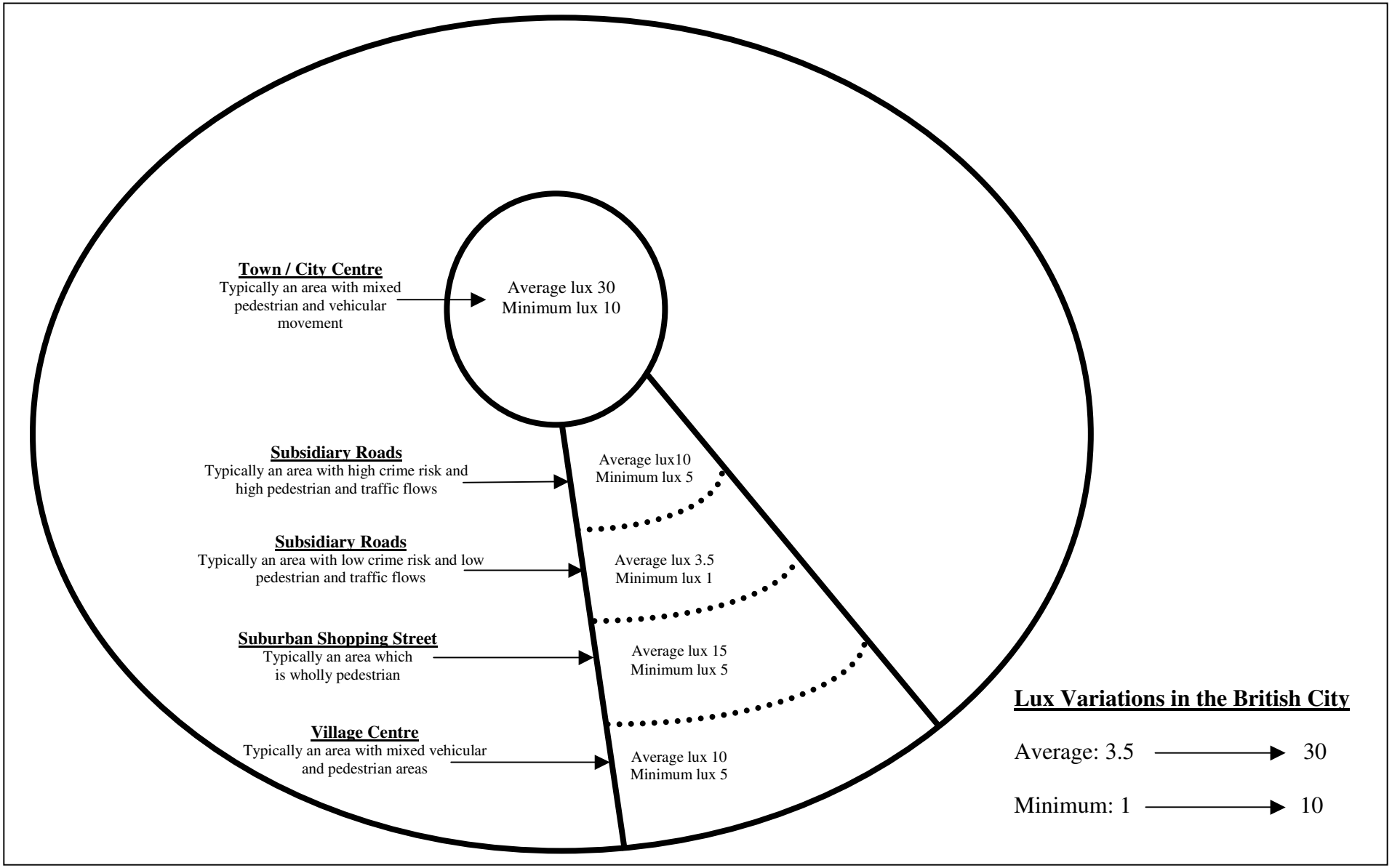
Table 3. Lighting Levels for General Traffic Situations

Category	Area Characteristics	Minimum lux Levels	Average Lux Levels
9/1	**City or Town Centre**		
9/1/1	Primarily vehicular	n/a	n/a
9/1/2	Mixed vehicular and pedestrian areas including service areas	**15**	**30**
9/1/3	Wholly pedestrian	**10**	**25**
9/2	**Suburban Shopping Street**		
9/2/1	Primarily vehicular	n/a	n/a
9/2/2	Mixed vehicular and pedestrian areas including service areas	**10**	**25**
9/2/3	Wholly pedestrian	**5**	**15**
9/3	**Village Centre**		
9/3/1	Primarily vehicular	n/a	n/a
9/3/2	Mixed vehicular and pedestrian areas including service areas	**5**	**15**
9/3/3	Wholly pedestrian	**5**	**10**

Source: BSI (1996, p3).

Figure 1 postulates how these standards might be geographically juxtaposed in relation to a city (see Figure 1).

Figure 1. A Stereotypical Arc of the City and Current Recommended Lighting Levels



Reference to Tables 1, 2 and 3 reveals how decision-making using the categorisations appears to be highly idiosyncratic, unscientific and open to criticism. Crawford and Wilson (2001) refer to 'transient adaption' as the visual adaptation that humans make when they move from an area of bright lighting to a contrasting area with lower levels of lighting (and vice versa), and crucially, young people are able to adapt far quicker than the elderly. The authors therefore argue for effective lighting, which they define as "lighting that puts light where we need it (and nowhere else) and where light will help visibility. That means: no glare, no light trespass, no direct uplight, no harsh shadows, no steep transitions from light to dark" (Crawford and Wilson, 2001, p77). Figure 1 simplistically hypothesises where such 'zones' of 'transient adaption' might be located within a cross section the city. It raises two important issues. Firstly, how do such transitions from well-lit areas to darker areas affect user perceptions and routine activities relating to various component parts of the after dark environment. Secondly, does the constrained and arguably limited process of categorising areas using recorded crime statistics and pedestrian / traffic flows, appropriately or adequately reflect the highly complex nature of crime and fear of crime in the community as it might relate to lighting and the after dark urban environment.

Various hypothetical scenarios could exist and raise concerns as to the potential success of such an approach to lighting Britain's streets.

- Poorly illuminated streets in Area 3/3 (subsidiary roads with high crime risk and pedestrian / traffic flows) may be subject to social dynamics, which conspire to under-report victimisation and offending. Atlas' concept of "Offensible Space" (1991) argues that criminals and drug dealers can actively control the streets via intimidation, in order to avoid unnecessary and unwanted police attention. Crime in such areas may well far exceed recorded crime and may actually require re-evaluation and re-designation in terms of the area categorisations of BS 5489.
- Pedestrian throughput levels need to be assessed and what constitutes low, medium and high levels of usage need to be defined. Furthermore, the poorly lit 'Area' 3/3 in the hypothetical model may have low street pedestrian use as a result of the intimidatory nature of "offensible space", further exacerbating the designation procedure.
- The area categorisation procedure does not account for areas where recorded crime is high and pedestrian street use is low. Furthermore, the procedure does not account for areas where recorded crime is low and pedestrian street use is high.
- Brantingham and Brantingham (1993) note the importance of nodes, paths and edges and argue that in urban layouts, such features may affect criminal opportunities. The "transient adaption" (Crawford and Wilson, 2001) that may take place in the hypothetical model may mean that cognitively, after-dark environments may possess different paths and edges that may relate to lighting levels and they represent a network of zones of transient adaption. These zones will also vary with age (young people adapt significantly quicker than the elderly).
- The most recent review of the lighting and crime literature found that lighting improvements were most effective at the small area level. The size of the areas

designated under BS 5489 may have implications regarding the aggregation of recorded crime statistics and in evaluating the effectiveness of lighting improvements.

Although studies have shown reductions in crime and in the fear of crime, the current standards (BS 5489) are based on horizontal luminance, "which are not necessarily ideal for this purpose" (Urbis Lighting Limited, 1995). Indeed, vertical luminance can enhance recognition (see Figure 2). BS 5489 recognises that high pressure sodium lighting which increases colour rendering "is particularly suitable for those areas where pedestrian activities predominate or where the crime risk has to be taken into account" (BSI, 1992, p4). However, Gardner (1999, p1) observes how in the UK "streets, roads and buildings are still bathed in the harsh, orange-gold pallor of high pressure sodium (SON) lighting" and that approximately 60% of street lighting (around 4 million units) is still equipped with low pressure sodium (SOX) with their 'deadly monochromatic yellow fog' (Gardner, 1999, p1), which seriously limits the visual enjoyment of the after dark environment and which were designed primarily for road safety. Street lighting using white light has been demonstrated to enhance colour rendering and in studies has reduced recorded crime and was positively received by users (Gardner, 1999, Bennett, 2000) but is not mentioned in BS 5489.

The Chartered Institute of Building Services Engineers (CIBSE, 1998) also provides guidance on the environmental considerations for exterior lighting (with light pollution representing a significant concern). They comment that in areas frequented by pedestrians "…high mounting heights can give unnatural shadows and should be avoided if possible" (CIBSE, 1998, p2). It is suggested that a proportion of Britain's street lighting may fall outside this category, having been designed principally for the safety of motorists, rather than the safety and security of pedestrians. Furthermore, lamps with a high colour-rendering index (i.e. fluorescent, metal halide and high pressure sodium) are far more acceptable to the general public than low-pressure sodium, whereby "…they enhance the recognition of faces and car colours in the street leading to a greater sense of pleasantness and security" (CIBSE, 1998, p2). Crucially, CIBSE also observe that vertical luminance is "important to reduce the fear of crime and to see facial expressions easily"(CIBSE, 1996, p2). Crucially, "the issue of vertical illuminance is not covered in UK road lighting standards" (Urbis Lighting, Limited, 1995, p2). Figure 2 illustrates how vertical luminance can affect recognition and visibility.

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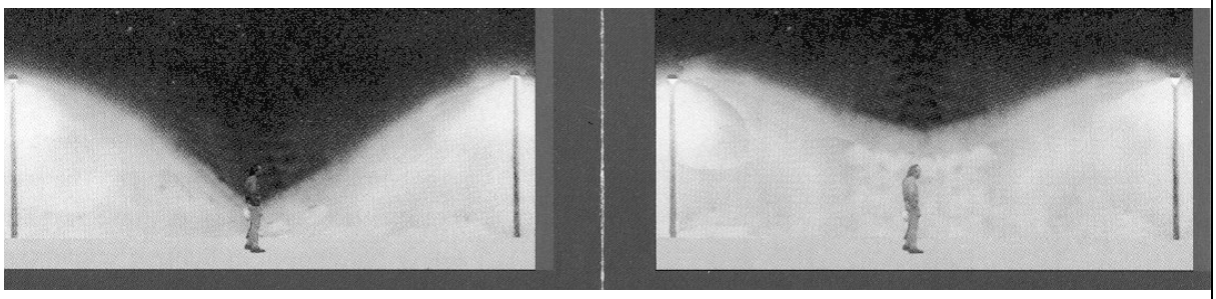
Figure 2. Vertical Illuminance and Recognition



Low vertical illuminance gives poor recognition

High vertical illuminance provides better recognition

Source: Urbis Lighting Limited (1995, pp2-3).
(The authors gratefully acknowledge permission from Urbis Lighting Limited to reproduce Figure 2).

Conclusions

This review of the literature and current street lighting standards (BS 5489) suggests that the potential crime reduction effect of improved street lighting can be enhanced by conducting research that can contribute towards understanding how users perceive the after dark environment and in particular, whether BS 5489 area categories of low, medium and high crime risk and pedestrian / traffic flows are appropriate. Given the 'dark figure' of crime, retaining such a method of categorisation is arguably myopic. Much research (Vrij and Winkel, 1991; Harries, 2000; Cozens *et al.*, 2001) has advocated the use of fear of crime mapping to run concurrent with the existing 'objective' analysis of recorded crime statistics. Since lighting is not a physical barrier to crime, its crime reduction effects are located in the perceptions of both users and potential offenders.

Pease (1999, p68) asks "given that the capacity of street lighting to influence lighting has been satisfactorily settled, how should policy move forward to reflect this" and suggests two ways. Firstly, that local authorities accept recent research findings and consider lighting schemes as part of their obligations under the Crime and Disorder Act 1998. Ballintyne *et al*., (2000, p4) succinctly observe "Section 17 [Crime and Disorder Act, 1998] encapsulates the spirit of the legislation by requiring local authorities to consider community safety implications inherent across all services".
Secondly, Pease (1999) calls for the dissemination of the findings from recent evaluations and existing knowledge of innovative uses of street lighting in the form of case studies. A major conclusion of this paper is that a thorough critical review and re-evaluation of BS 5489 is needed.

Research and Policy Implications

Various priorities for policy and future research can be derived from this review of crime and lighting research and BS 5489.

- Future evaluations need to consider both experimental design and the selection of appropriate control areas. The use of randomised experimental designs (as

advocated by Sherman *et al.,* 1997) may offer significant pay-offs for future researchers.

- Government Planning Policy Guidance (PPG) could more explicitly refer to the after dark environment and recommended lighting levels.
- Research is required into the perceptions of users' concerning what is considered to be adequate lux levels for street lighting. Different user groups (e.g. the young, the elderly, residents, offenders, the emergency services, pedestrians, cyclists and motorists) may provide interesting insights into this issue.
- The 'Area' categorisation process (see Tables 1 and 2) requires modification to more realistically reflection the diversity of characteristics found in different streets, estates and locations.
- Local authorities should conduct detailed street lighting audits to identify where standards are met and where they are not and seek funding from the government to improve street lighting where appropriate.
- Research might appropriately be conducted on the combined effects of CCTV and improved street lighting on crime and the fear of crime in different urban spaces.
- The use of fear of crime and victimisation surveys to map crime can provide a more holistic understanding of crime in the community and of the effectiveness (or otherwise) of crime reduction initiatives, including street lighting improvements. Furthermore, Nasar (1998, p11) argues, "surely we can develop evaluative maps of cities to use for the analysis and improvement of city appearance".
- Research into the possible effects on crime, fear of crime and visibility of zones of "transient adaption" (Crawford and Wilson, 2001) may contribute considerably towards the debate concerning the uniformity of lighting.
- Daytime cognitive mental maps of fear have been shown to differ in the after-dark environment (Hanyu, 1995; Parkes and Thrift, 1980) and research in the local context is necessary. Furthermore, researching how the after-dark environment may influence nodes, paths and edges (Brantingham and Brantingham, 1993) in the city is also a potentially fruitful priority.
- A consideration of the colour rendering of white light and the enhanced recognition provided by vertical luminance within BS 5489 may contribute to improving the crime reduction of street lighting.

Understanding how different groups regard different levels of lighting in terms of their personal and community safety are clearly research priorities. Indeed, since the population is ageing, how the elderly (who are more likely to suffer some form of visual impairment) perceive lighting levels is a potentially fruitful area for future exploration. How offenders perceive lighting levels and how they might alter their behavioural patterns also represents an area for potential investigation, notwithstanding the crucial perceptions of residents and pedestrians who might routinely utilise the streets. Such studies may therefore provide a 'subjective' dimension that can complement the existing 'objective' dimension provided by official crime statistics. Improved lighting can certainly reduce crime and the fear of crime when implemented in conjunction with other crime prevention initiatives. However, the potential crime reduction effect of improved lighting can be further enhanced by broadening our understanding and mapping the perceptions of different groups (legitimate and illegitimate users) as they

relate to lighting levels and lighting standards in their communities. Such a development would contribute towards redressing the accusation that society remains in the dark about the relationship between street lighting levels and crime and fear of crime and also contribute towards achieving what Pease (1998, p2) has referred to as 'context-appropriate lighting'.

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