

An Environmental and Behavioural Analysis of Arson
in a Danish Sample

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Abstract

Background: Despite its significance as a costly and destructive criminal behaviour, there appears to be some consensus that we know relatively little about arson compared to many other areas of criminal behaviour. Moreover, most existing theory and research into arson has come from the USA, and has tended to concentrate on profiling the characteristics of offenders, rather than investigating, at least in any detail, features of the environment that may influence their behaviour.

Aim: The main aim and overarching theme of the current thesis was, therefore, to describe and evaluate some of the main demographic and biographical characteristics, offence related behaviours, and environmental factors associated with arson, in a sample of arson offenders from a European country.

Methods: Six empirical studies were conducted, each based on cases drawn from a sample of 746 cases committed by 540 offenders from Denmark between 2002 and 2010 in two police districts, one rural and one urban. Studies 1 and 2 examined a range of demographic and biographical characteristics of arson offenders (such as, gender and age); Studies 3 and 4 covered offence related behaviours (such as selection of targets, and travel distances), and employed regression analyses to look specifically at how these were predicted by other offence related and demographic and biographical variables. Study 5 then investigated the prediction of serial offending as an indicator of arson recidivism using the above demographic and biographical variables and offence related variables. Finally, Study 6 attempted to employ a new approach, via Google Earth, to examine the influence of a range of architectural and structural features of the environment on arson offending; these included

targets, presence of high rise buildings, territorial markers, population density and maintenance.

Results and Discussion: Findings supported previous literature in identifying the typical arsonist as a young male offender; however, the results further suggested three possible divergent trends in the data corresponding to different categories of arson offender: 1) a more frequent opportunistic arsonist; 2) a less frequent, but more serious, often more persistent serial offender, and 3) a category of mainly female offenders who are less likely to be serial offenders but who may be reacting to dysfunctional home environments. Importantly, in relation to the latter finding, a bimodal peak in age emerged in the subgroup of female offenders, identifying a younger group of female offenders in their mid and late teen years and an older subgroup of female offenders in their late thirties and early forties. Another notable finding was that young male offenders who were not at school were particularly at risk for becoming serial offenders, suggesting that young males not attending school could be targeted in terms of prevention of persistent arson. Also, as predictors of arson, a number of environmental variables were significant and in line with predictions (for example, arson was more prevalent where there were vacant buildings, and very significantly, where the nearest police station was farthest away), but others were significant in a direction opposite to predictions (high building density was associated with lower rates of arson), and some potentially important predicted relationships failed to emerge as significant predictors (such as territorial markers). In addition to the above, two other major findings emerged. First, whilst it was possible to predict crime scene behaviours from other crime scene behaviours with some degree of accuracy, and, similarly, demographic behaviours (like previous arson) from other demographic factors, predicting crime scene behaviours from demographic factors and vice versa proved to be considerably more difficult. In contrast, in terms of having

maximum impact on arson rates the environmental variables considered here did a relatively good job of predicting the presence of arson. A number of limitations and implications are also discussed.

Conclusion

Considering the results as a whole, notwithstanding some success in predicting arson from demographic and offence related variables, it is concluded that an extension of the kind of environmental approach explored in this thesis could potentially be used for developing environmental schemes for arson prevention that might be considerably easier to apply, and perhaps even more effective in reducing arson, than targeting 'at risk' groups of individuals.

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Part 1

Literature Review and Background

Chapter 1

The Problem of Arson

1.1. Introduction: The Problem of Arson

The crime of arson has long featured in the history of criminal behaviour (Hagan, 2010; Hall, 2005; Holst & Lystrup, 2014; Jones, Porter and Turner, 1984; Kjeldbjerg, 1996; Stickle & Blechman, 2002), and has been recognised as among the most costly and destructive of criminal behaviours (Brett, 2004; Cahn, 1998; Davis & Lauber, 1999; Doley, 2003; Epps & Hollin, 2005; Jackson, Hope, & Glass, 1987; Pearson, 1994; Tennent, McQuaid, Loughnane, & Hands, 1971). For example, in 2015 in the USA, the National Fire Protection Association (NFPA) reported 1,345,500 arson related fires which caused 3280 deaths, 15,700 cases of injury, and cost \$14.3 billion in property damage. For educational properties alone, between 2009 and 2013, the annual average cost of fires in direct property damage was estimated at £88 million, as well as one civilian death and 79 injuries per year (NFPA, 2016). The cost of arson, therefore, concerns not just the cost of the structures that have burned down, but also the deaths of and injuries to civilians and firefighters, increased insurances, increased taxes to support firefighters, police and court services involved in the aftermath, use of additional schools and institutions while the burned down structures are rebuilt, and loss of jobs and revenues in the damaged businesses, some of which might be unable to re-open (Hagan, 2010).

Clearly then, arson has long been recognised as a very influential problem in society; however, before exploring the topic further, it is important to decide on a working definition of arson and definitions of some related concepts that can be applied in this thesis.

1.2. Definitions

1.2.1. *Fire-setting and Arson*

In terms of definitions, perhaps the most obvious primary distinctions to make are those between arson and fire-setting. It is often argued that for fire-setting to be recognised as arson, it must be motivated by criminal intent; i.e. without criminal intent the crime of arson has not taken place. Hence Burton, McNeil and Binder (2012) state, '*fire-setting is a behaviour, arson is a crime*' (p. 355); thus not every fire-setter is an arsonist and, accordingly, arson excludes accidents. Turvey (2002) also recognises the distinction between fire-setting and arson as one between an overall classification for a behaviour (fire-setting) and one in which guilty intent can be established according to penal classifications (arson).

Another related perspective on the difference between fire-setting and arson concerns age. For example, Hickie and Roe-Sepowitz (2010) have argued that the more general term 'fire-setting' better describes the behaviour of many juveniles who accidentally set fires, or do so out of curiosity or impulsivity, while the term 'arson' is best applied in a more limited way to an intended crime. This is not to imply that fire-setting by juveniles is not malicious; indeed, the cost of juvenile fire-setting to society may be considerable, both in terms of property damage and deaths and injuries. For example, Slavin (2004) reported that juvenile fire-setting is responsible for an estimated 600 deaths and over 30,000 injuries each year in the USA (see also, Stickle & Blechman, 2002). However, the essential issue here concerns the age of criminal responsibility; i.e. the younger the fire-setter, the less he or she might understand the consequences of fire setting and hence less malicious intent may be involved (Hickie & Roe-Sepowitz, 2010). Nevertheless, this opens up a proverbial can of worms in terms of definitions. If fire-setting is construed as a superordinate category, i.e. arson is a form of fire-setting, it makes no sense to argue that juveniles engage in fire-setting not arson. Presumably, therefore, what Hickie and Roe-Sepowitz (2010) mean is that there are different

forms of fire-setting; these might include, for example, accidental fire-setting, intentional but not malicious fire-setting (as when burning woods or fields to promote growth etc.), malicious but not criminally responsible fire-setting (juvenile fire-setting), and criminal fire-setting or arson (which implies, malicious intent, and assumes the individual has reached an age where criminal responsibility can be assigned).

Other definitions of arson pay more attention to the general notion of malicious intent, rather than, more strictly, to whether criminal responsibility can be assumed; for example the FBI's Uniform Crime Reporting Program defines arson more generally as: *... any wilful or malicious burning or attempting to burn, with or without intent to defraud, a dwelling house, public building, motor vehicle or aircraft, personal property of another, etc.* (Williams, 2005, p.1). Given the above considerations, to avoid unnecessary semantic complications, including debates and assumptions concerning the age of criminal responsibility, it was considered sensible to adopt this wider definition of arson in the present thesis.

1.2.2. Pyromania

Nevertheless, there is still an issue of whether or not the definition of arson should include pyromania. It is a common fallacy that most fire-setters are pyromaniacs, whereas the diagnosis of pyromania is actually very rare (Barnett & Spitzer, 1994; Brett, 2004; Geller, 1987; Geller, 1992; Harris & Rice, 1984; Mannysalo, Putkonen, & Lindberg, 2009; Rice & Harris, 1991; Stewart, 1993; Smith & Short, 1995). Burton et al., (2012) have argued that pyromania is to be distinguished from both fire-setting and arson; hence their full statement is, *'fire-setting is a behaviour, arson is a crime and pyromania is a psychiatric diagnosis'* (p. 355). However, the diagnosis 'pyromania' is also, in itself, a much debated classification. For example, according to the Diagnostic and Statistical Manual of Mental Disorders (DSM-5; American Psychiatric Association, 2013) individuals should not be diagnosed with

pyromania if their fire-setting occurs as a result of conduct disorder, antisocial personality disorder, hallucinations or other neurological conditions or intellectual disabilities, substance intoxication, monetary gain, revenge, or other malicious intent. However, if we adopt this view, this presumably limits what kinds of psychiatric diagnosis can be applied to pyromania. Hence DSM-5 defines pyromania in a more limited way as a pattern of deliberate setting of fires for pleasure or satisfaction derived from the relief of tension experienced before the fire-setting. In fact, DSM-5 lists pyromania under Impulse-Control disorders, along with, for example, intermittent explosive disorder, kleptomania, pathological gambling, antisocial personality disorder and conduct disorder.

Pyromaniacs are also sometimes called ‘excitement arsonists’, because they set fire due to a morbid fascination of setting the fire and watching it (Hagan, 2010). So, essentially we are left with the idea that pyromania is limited to some kind of pleasure or satisfaction derived from a relief of tension by setting fires, rather than the result of some kind of wider psychological pathology, or instrumental motivations (Doley, 2003; Huff, Gary & Icové, 1997). How many arsonists are, in fact, pyromaniacs according to this kind of definition is not known, but three to six percent of psychiatric inpatients have been reported to meet the criteria for pyromania (Grant, Levine & Kim, 2005; Lejoyeux, Arbaretaz & McLoughlin, 2002).

However, if we again confine arson to criminal intent, presumably this opens up the possibility that pyromania is not necessarily arson in cases where pyromaniacs are assumed to be mentally ill such that their judgment is impaired. Supporting the use of the FBI definition, therefore, most authorities appear to construe pyromania as a subcategory of arson, rather than assigning it to a different category; and this is how it will be considered in this thesis.

1.3. Is Arson on the Increase?

Despite the significance of arson as a problem for society, there seems to be some consensus among both researchers and legal authorities that, compared to many other areas of criminal investigation, we appear to know relatively little about it (Hopkins, 2009; Lindholm Mikkelsen, Falkengaard & Jacobsen, 2000; Reno, Marcus, Leary & Samuels, 2000). Hence there are often inconsistencies in reports and findings; for example, there appears to be an overall perception that arson is increasing in western society (see, for example, Hakko & Vaisanen, 1995; Leslie, 2003; Lindholm Mikkelsen et al., 2000; Tague & Knox, 2013). However, in Denmark (which is the focus of the studies in this thesis) there has been a slight decrease in arson in 2014 and 2015, whereas before, arson rates were relatively stable for several years. Thus the number of reported arson cases in Denmark in 2002 was 1136 and 456 people were charged with arson, whereas the number of reported arson cases in 2013 was 1168 with 480 people charged with arson; i.e. the numbers are very similar. But during 2014 and 2015, the numbers dropped from 873 reported cases and 378 people charged with arson (2014), to 768 reported cases and 329 people charged with arson (2015) (Brandstiftelse, Danmarks Statistik, 2016). In contrast, in the USA there was a 3.7 percent increase in the number of fires reported in 2015 compared to 2014 (NFPA, 2016), and in England there was a 22 percent increase in fire related fatalities, and the fire and rescue services attended seven percent more fires, in the period from April to September 2015 compared to the year before (Department for Communities and Local Government, 2016). Also, in Japan, according to the National Police Agency, arson increased by 18 percent from 1996 to 2004 (Wachi, Watanabe, Yokota, Suzuki, Hishino, Sato, & Fujita, 2007).

In recognition of such inconsistencies, the USA based NFPA (National Fire Protection Association) have argued that general statements regarding an overall increase in arson rates may disguise individual variation in locations, and exaggerate perceptions. They

argue that, in reality, the issue of whether arson is increasing or decreasing might depend on the particular area in question; in some areas where the malicious fire-setting continues unhindered, it might be increasing, whereas other areas may be untouched or have decreasing arson rates. Reported arson rates may also fluctuate depending on how arson is defined, detected and what preventative measures are applied by the police and fire departments. Reported variations in the numbers of arson cases might also be influenced by policy changes and differences in regulations and how they are handled alongside factors such as the demographic profile of the community (Sapp, Huff, Gary, Icove, & Horbert, 1994). In fact, evidence is generally lacking as to why arson rates sometimes fluctuate to a very high degree even in areas in close vicinity to each other (Bennett, Merlo & Leiker, 1987).

1.3.1. Detection and Conviction Rates

One major difficulty associated with uncovering the nature and causes of arson is the relatively low conviction rate. According to NFPA, in the USA, of all the set fires that are reported to fire departments one-third are confirmed as arson. However, of these, 80 to 85 percent are never solved or cleared by an arrest (see also Burton et al., 2012). Moreover, about half of those arrested are not prosecuted, and about one third of those prosecuted are not convicted. Altogether, the percentage of set fires for which someone is convicted is roughly two percent. About one-third of those convicted receive no jail or prison time, and the majority of those sent to jail or prison get less than two years. Once released, more than half of those who were incarcerated are rearrested for something, though not necessarily arson, within three years (NFPA, 2016). The same problems occur in other countries; for example, in Denmark in the time period from the mid-1980s to mid-1990s there were between 1500 and 2000 reported arson cases, but only around one-third of them were solved (Kjeldbjerg, 1996). All this is made more pertinent by the fact that, in the USA at least, only

fires that have been investigated are included in the statistics and not fires of suspicious and unknown origin (Hagan, 2010). However, it should be pointed out that, in the USA, the NFPA and FBI solve around same numbers of arson cases as any other serious crime (homicide, rape, violence) (Hall, 2005), whereas in England and Wales the detection rate for arson is consistently lower than for many other crimes (Walker, Kershaw, & Nicholas, 2006); also, as mentioned above, only one third of arson cases are solved in Denmark (Kjeldbjerg, 1996).

Perhaps the most problematic issue for detecting crimes of arson is, like some other crimes, they go unwitnessed (Hall, 2005; NFPA, 2016). However, this may be compounded further by the common view that arson cases are by nature more difficult to solve as the majority of the evidence is burnt in the fire. Lindholm Mikkelsen et al. (2000) argue that this is actually a misconception as every fire has its own fingerprint and, therefore, it should be possible to find the cause of the fire more often than is presently the case. The NFPA also dismiss the view that arson potentially destroys all evidence, and Hall (2005) agrees, pointing out that in 40 percent of structure fires there is no flame beyond the area of origin and therefore, it is very likely that a fire would leave some evidence untouched; moreover, arsonists rarely go to extreme lengths to conceal their fires. Turvey (2002) further argues that elements like victimology (individual, group, political, etc.), type of property targeted, accelerants, point of origin (where the fire started), offender skills and the state of the crime scene could all potentially be used as means of efficiently solving the crime. However, he provides no evidence for this. Considering Lindholm Mikkelsen et al.'s (2000) statement that it should be possible to find the cause of the fire more often, it might simply be that having a pessimistic outlook might hinder solving an arson case, as they might perceive it as a lost case to begin with and might even handle the evidence accordingly.

1.4. Conclusion

To summarise, for the purposes of this thesis, arson is defined as, *Any wilful or malicious burning or attempting to burn, with or without intent to defraud, a dwelling house, public building, motor vehicle or aircraft, personal property of another, etc.* (from Williams, 2005, p.1).

However, there seems to be some consensus that our knowledge of this kind of behaviour is somewhat limited, not only in terms of systematic empirical research, but also in practical application. Moreover, this general lack of knowledge and experience may play an important role in why the detection and conviction rates are as low as they are, particularly in countries such as Denmark and the UK where conviction rates tend to be particularly poor relative to many other crimes. As noted above, there is some suggestion that firefighters and police officers, are under the impression that all or most of the evidence will have been destroyed, often ignore and fail to preserve the evidence, or even destroy it completely. Clearly, if this is the case, more could be done to inform the relevant authorities of the importance of keeping the crime scene intact. But obviously, it is also important to gather as much research evidence as possible regarding factors that might relate more generally to behaviours and environments to narrow down, or provide guidance as to, possible lists of suspects. For example, we need to know who usually targets whom, and whether can we differentiate between different crimes scenes and match them with a certain type of offender. With regard to the latter, we know that different environments often have very different arson rates; even areas very close to each other can differ greatly in arson rates, but we have very little evidence as to why this occurs (Bennett et al., 1987). This is primarily because previous studies on arson have tended to focus on whole towns, cities or even countries when investigating arson rates from an environmental perspective, without considering this level of detail. However, before we go into the environmental perspective in more detail, it may be

useful to consider what research has been conducted on the issues of who are typical arsonists, why they set fires, and where.

Chapter 2

Previous Research and Theory on Arson

2.1. Introduction

Having briefly introduced the problem of arson and agreed a definition, this chapter will consider in more detail previous theory and research in the area.

Until relatively recently, most research into arson has tended to emphasise the psychological characteristics of the offender, with little emphasis on situational influences. For instance, up to the middle of the 20th Century, approaches to arson tend to be dominated by psychoanalytic principles; hence arson was construed by some as an expression of repressed sexual urges and desires to urinate, and, as such, the main view of the arsonist was of someone mentally ill, and often a sexual deviant (Geller, Erlen & Pinkus, 1986; Macht & Mack, 1968). The focus then shifted from sexually rooted problems towards mental and behavioural problems such as conduct disorder (Forehand, Wierson, Frame, Kemptom, & Armistead, 1991), attention deficit/hyperactivity disorder, anxiety problems, depression (Dadds & Fraser, 2006), suicidal tendencies (Räsänen et al., 1995) and antisocial personality traits (MacKay et al., 2006); all of which have been associated with arson in the more recent literature.

Correspondingly, theories of arson have also tended to concentrate on characteristics of the offender, albeit approaching the subject from different angles according to the emphases they adopt; for example, whether their concerns are therapeutic, investigative, biological, neurological or social.

2.2. Theoretical Approaches

Typological theories of arson, for example, have often had therapeutic origins; i.e. their aim is to create descriptive classifications, which may be useful for treatment purposes. Such theories attempt to derive a number of typological postulates from a combination of offence characteristics and hypotheses about motivational factors underlying the firesetting.

There are numerous examples of this kind of approach (see, for example, Barker, 1994; Bradford, 1982; Faulk, 1994; Icove & Estep, 1987; Inciardi, 1970; Lewis & Yarnell, 1951; Prins, 1994; Prins, Tennent & Trick, 1985; Ravataheino, 1989; Rider, 1980; Rix, 1994; Scott, 1974; Vreeland & Levin, 1980), but three perhaps stand out as particularly influential in guiding classifications. One of the earliest attempts at a systematic categorisation was that of Lewis and Yarnell (1951). From a study of 2000 examples of firesetting, they identified five categories: unintentional (such as through temporary confusion), delusions (such as psychosis), erotic pleasure (such as, pyromania type traits or sexual fetishism), revenge (such as, jealousy or feeling offended), and a 'child' category of firesetters who start fires out of mischief or excitement. Although aspects of this classification were subsequently adopted by others, Lewis and Yarnell did not develop or suggest any psychological implications for their approach (Gannon & Pina, 2010).

Following from this, one of the most enduring typological classifications was that developed by Inciardi (1970). In this, offenders are classified according to motives and associated demographic, personality and behavioural characteristics. For example, Inciardi proposed that 'revenge arsonists' would tend to be loners and have an alcohol problem, whereas 'excitement arsonists' would tend to be younger and more likely to remain on the crime scene and watch the aftermath. 'Insurance claim' arsonists would then tend to be older and more intelligent, whereas 'vandalism offenders' would tend to be younger and of lower

intelligence; and 'crime concealers' (who used arson to cover up evidence of another crime), would also tend to be of higher intelligence (Inciardi, 1970).

Others have attempted to simplify the categorisation; for example, according to Faulk's (1994) later classification, arson offenders can be broadly classified according to whether the crime was motivated, instrumentally, as means to an end (for instance, for financial gain, crime concealment, revenge, to relieve boredom, as a cry for help, to become a hero, to end one's life, or to enhance self-esteem), or whether the crime was intrinsically motivated (for example, because of pyromaniac tendencies, sexual excitement, or affect regulation). However, critics have argued that these kinds of classification typologies tend to suffer from lack of clarity; often the categories overlap and/or are difficult to define and establish empirically (Gannon & Pina, 2010).

Other theoretical approaches have adopted a more investigative orientation and attempted to infer firesetting typologies or themes from a wide variety of sources including an examination of crime scene details, such as, choice of ignition methods and fire target, and clues indicating efforts at identity concealment and repeat offending (Canter & Fritzon, 1998; Douglas, Burgess, Burgess, and Ressler, 1992; Kocsis, 2007; Kocsis & Cooksey, 2002; Kocsis, Irwin, & Hayes, 1998; Wood, 2000). For example, in a study of serial arsonists, Sapp, Huff, Gary, Icove and Hobort, (1994) found that more than half of the sample of the arsonists left evidence of accelerant materials and/or used matches or some other sort ignition device at the crime scene which could potentially be used to aid identification. There is also some evidence that arsonists who set fires for crime concealment or financial gain, most often target cars or residential properties (Wood, 1999). Moreover, if the targeted car has been used for joy riding the offenders are likely to be young adolescent males, offending in a group, under the influence of alcohol or drugs and living in the nearby area (Douglas et al., 1997). Similarly, fire vandals tend to be young males who set fires in areas of social deprivation,

particularly if the targets look unattended and not cared for. In the latter case, the offending tends to be unplanned, and may be strongly influenced by peer pressure. In contrast, it has been proposed that arsonists who set fires for revenge (which is often the case with those who have a psychiatric history), usually set fires alone, plan their attacks and know their victims; hence the majority bring materials to the crime scene. They also often act under the influence of alcohol or drugs. This type of arsonist tends to use flammable liquid accelerants more than any other type of arsonist (Wood, 1999). Relatedly, a study of serial and spree arsonists, Santtila, Fritzon and Tamelander (2004) found that, in 67 percent of the offences, matches were used to light the fire, and in 63 percent of the offences the offender brought material with him or her, and 51 percent of the offences were committed under the influence of alcohol or drugs. However, in this sample, only 21 percent of the offences were planned, and in only 5 percent of the offences the victim was known to the offender. Assuming such results are replicable, these kinds of variables could potentially be used to profile the kind of person most likely to have committed a certain crime.

One of the earliest attempts at systematically profiling firesetters from their crime scene behaviours was that of Douglas, Burgess, Burgess and Ressler (1992), who used two dichotomised categories, organised and disorganised firesetting. However, their methods were subjective and unsystematic. In a more systematic approach, Canter and Fritzon (1998) analysed details of 175 solved crimes using details from a number of sources including information obtained about the crime or from the crime scene (for example, use of accelerants, and evidence of suicide notes or previous disputes with the targeted victim). They propose four interacting themes or typological profiles based on inferred motives (instrumental or expressive) and the target of the attack (person or object). Thus, for example, an offender who repeatedly targets other people as a form of revenge might be classified as ‘instrumental person’; whereas a young firesetter who sets fire opportunistically to buildings

for criminal goals might be classified as ‘instrumental object’, and an offender with a psychiatric history who repeatedly sets fires to satisfy a fascination for fire might be classified as ‘expressive object’. However, although these themes have been replicated in other samples (Almond, Duggan, Shine, & Canter, 2005; Santtila, Häkkänen, Alison, & Whyte, 2003), Kocsis and Cooksey (2002) have come up with four rather different categories, based on adult recidivist firesetters in Australia: these are, thrill, anger, wanton, and sexual. The sexual category, in particular, seems difficult to reconcile with Canter and Fritzon’s scheme (Gannon & Pina, 2010).

Numerous attempts have also been made to identify arson related typologies using biological and neurological impairment markers. The main assumption underlying these approaches is that persistent firesetters possess certain anomalies such as glucose metabolism abnormalities, and neurotransmitter defects; in particular, decreased concentrations of cerebrospinal fluid monoamine metabolites; i.e., 5-hydroxyindoleacetic acid; 5-HIAA, and 3-methoxy-4-hydroxyphenylglycol; MHPG. Also, it has been suggested that a number of brain and chromosome abnormalities may be involved in firesetting behaviours, including poor frontal lobe function, posterior abnormalities, epilepsy and Klinefelter’s or *XXY* syndrome (for examples, see Barnett & Spitzer, 1994; Calev, 1995; Carpenter & King, 1989; Eytan, Paoloni-Giacobino, Thorens, Eugster & Graf, 2002; Friedman & Clayton, 1996; Kaler, White, & Kruesi, 1989; Meinhard, Oozeer, & Cameron, 1988; Nielsen, 1970; Roy, Virkkunen, 1984; Virkkunen, Guthrie, & Linnoila, 1986; Virkkunen, Goldman, Nielsen, & Linnoila, 1995; Virkkunen, Nuutila, Goodwin, & Linnoila, 1987; Virkkunen et al., 1994; Virkkunen, De Jong, Bartko, & Linnoila, 1989). However, although there appears to be evidence for such biological and neurological correlates in some cases of firesetting behaviour, such examples tend to be case study based and are generally very rare. Hence,

replication has been a problem, and by themselves, such approaches appear to have very limited general predictive value (Gannon & Pina, 2010).

In contrast with the above, social learning approaches tend to go to the other extreme and concentrate more or less exclusively on historical and present situational influences. The basic principles of the social learning approach derive from Bandura's (1976) conceptual framework which considers behaviour to be highly influenced, and sometimes solely determined by, factors such as reinforcement, modelling and imitation (Kazdin & Kolko, 1986; Macht & Mack, 1968; Singer & Hensley, 2004; Vreeland & Levin, 1980). Social learning has been widely applied to criminal behaviour in general; however, with specific regard to arson, Macht and Mack (1968), for example, reported that arsonists' fathers often have occupations where they are exposed to fires to a high degree, including fire-fighting. Also firesetters can often come from families with a history of firesetting (Rice & Harris, 1991). However, it has been argued that although social learning theory may account for the general facilitation of firesetting behaviour, it is too broad and has little predictive value in accounting for individual differences. For example, it does not readily explain or account for the behaviours and motivational sources of various possible subgroups of firesetters, such as, firesetting for excitement, revenge, monetary gain, or because of mental health issues (Gannon & Pina, 2010).

However, one approach that does attempt to delve deeper into the range of factors and processes underlying arson related behaviour is Functional Analysis Theory (Jackson, Glass & Hope, 1987; Sturmey, 2008). According to this approach, firesetting is facilitated and maintained via a complex interaction of previous circumstances and events, and psychosocial disadvantages; these include poor caregiver relationships, self-loathing, depression, self-esteem issues, poor conflict skills and rejection from others, individual fire experiences and internal or external firesetting triggers. Hence it has been hypothesised, for example, that

children who experience significant social difficulties might be more likely to engage in firesetting behaviour, as it gives them some form of power, influence and acceptance from their peers, that might ordinarily be unobtainable due to their poor social repertoire and lack of attention from caregivers. However, although there appears to be support for some of the components of Jackson et al.'s theory, such as many firesetters appear to experience strong negative affect, and feelings of low self-worth preceding firesetting (Murphy & Clare, 1996), as yet there has been little attempt to test the theory as a whole (Gannon & Pina, 2010).

Another way of attempting to provide a conceptual framework for profiling arsonists has been to concentrate on characteristic behaviours without necessarily inferring motive. For instance, Sapp, Hobort et al. (1994) reported that roughly one third of the offenders they studied remained at the crime scene; another third left the immediate crime scene but continued to observe the fire and the action surrounding the fire from a distance, whilst others left the crime scene entirely and never returned. Moreover, after the firesetting, some offenders reset the fire in the same location. In addition, most set fires after school or work; i.e. only a few do so on their journey from home to school or work or during the weekend. It has been argued that variations and patterns in such indicators may potentially allow investigators to build up behavioural profiles of different kinds of arson offenders.

One particularly systematic example of this kind of behavioural profiling approach is geographic profiling. Geographic profiling is a criminal investigative methodology that analyses the locations of the crime scene with the aim of determining the most probable area of offender residence. The aim is to aid the police by narrowing down the number of suspects to the ones living in a particular area where the offender is most likely to reside. It has reportedly been used with success with a variety of crimes including murder, rape and, most importantly here, arson (Le Comber, Nicholls, Rossmo & Racey, 2006). Given the fact that this approach concentrates on only a very narrow aspect of arsonists' behaviour, it is

obviously limited as a conceptual approach (indeed, it does not purport to provide a general theory of arson). Nevertheless, given that its main tenets are directly and fairly easily empirically testable, and its potential as part of a 'toolbox' for aiding our understanding of arson, and identifying possible arsonists, it will be selectively considered in more detail later in this chapter.

2.3. Motivational Aspects of Arson

Many of the aforementioned theories rest on the assumption that arsonists may display certain motivational characteristics that may be used to predict their behaviours; and correspondingly, the motivation behind firesetting behaviour has been one of the most researched factors in the field. Indeed, there appears to be a general consensus that motivation may be a useful way of classifying arsonists, and that one might expect identifiable behavioural differences between subgroups of arson offenders in relation to motivation (Hicks & Sales, 2006).

In accordance with a number of theoretical approaches, revenge has commonly been reported as the most frequent motivation for arson amongst both males and females (Barker, 1994; Harmon, Rosner & Wiederlight, 1985; Hill, Langevin & Paitich, 1982; Koson & Dvoskin, 1982; Leong, 1992; Prins, Tennent & Trick, 1985; Ritchie & Huff, 1999; Rice & Harris, 1991; Rix, 1994; Sapp, Icove et al., 1994; Sapp, Hobort et al., 1994; Stewart, 1993), followed by excitement, family problems, alcoholism and depression, financial gain, vandalism and crime concealment (Sapp, Icove et al., 1994). However, results have been inconsistent; for example, Grant and Kim (2007) found the most common reasons for firesetting were boredom, stress, feelings of inadequacy and interpersonal conflict, rather than the above. Moreover, others have proposed that motives may differ according to demographic characteristics. For example, some have proposed that only women are most likely to be

motivated by revenge (Bourget & Bradford, 1989; Lewis, & Yarnell, 1951; Scott, 1974; 1951; Scott, 1977); males are most likely to engage in firesetting because of frustration or aggression (Bourget & Bradford, 1989; Lewis & Yarnell, 1951; Scott, 1974; Scott 1977). Also, in those who are mentally ill, the most common motivation for arson has reportedly been as attention seeking behaviour, a cry for help, or a way of communicating (Bradford, 1982; Geller, 1992). In accordance with Functional Analysis Theory, other motivations for firesetting behaviour may involve arson for power or for acknowledgement (Kristelig Dagblad, 1999).

There are other, very obvious, limitations with this kind of approach. Motivation is clearly only one of many variables that contribute to arson behaviour in a particular context, and motivation is often very difficult to establish; most often it has to be inferred from other sources of information (Gannon & Pina, 2010). Also, and very significantly, motivation and intentions may change, sometimes quite radically, between different times, places and situations (Almond et al., 2005; Canter & Almond, 2007).

2.4. Demographic and Biographical Characteristics of Arsonists

Another main focus of research into arson, alluded to above, has concerned the demographic and biographical characteristics of arsonists; so again it is useful to review some of the main findings here.

2.4.1. Gender

Gender is often investigated in considerable detail in research into subtypes of crime. The literature on offending in general suggests that males and females differ in relation to frequency of the criminal activity, as well as type of criminal activity. For example, overall, proportionally, males tend to receive more criminal convictions than females; however, males

are more likely to be involved in sexual and violent offences, more likely to repeat offend and also commit more serious crimes, whilst females are more likely to be involved in less serious offences such as shoplifting and involvement in certain property offences (Archer, 2004; Card, Stucky, Sawalani, & Little, 2008; Dean, Brame, & Piquero, 1996; Gittens, 2011; Moffit, Caspi, Rutter, & Silva, 2001; Owens, 2002; Steketee, Junger, & Junger-Tas, 2013; Wolfgang, Thornberry, & Figlio, 1987). For example, in Denmark, a study by Justitsministeriets Forskningskontor (Justice Department Research Office, 2015) investigated youth crimes (under 18 years old) in the period between 2001 and 2014. They found a clear gender difference in relation to crime frequency, as well as specialisation; more males were convicted, but their activity mainly concerned burglary, theft and vandalism, whereas female criminal activity mainly involved shoplifting. However, again results have not always been consistent; other studies have indicated that females in general tend to show the same patterns of criminal behaviour as males, but less frequently (Steffensmeier & Allan, 1996; Warren & Rosenbaum, 1987).

With regard to arson specifically, therefore, one might expect a preponderance of males, as males tend to commit more crimes overall, and also perhaps more crimes of a serious nature. However, trends seem to have changed over time. For example, Marc's survey of 1825 to 1832 found that 34 percent of firesetters were female. Similarly, in Monkemoeller's study of firesetting from 1912, 37 percent of their sample were female, and, in 1914, Schmid reported that 35 percent of firesetters were females (all cited by Lewis & Yarnell, 1951). However, Lewis and Yarnell's study from 1951 found that only 15 percent of firesetters were female, which is very similar to more recent studies on arson (Bourget & Bradford, 1989; Fineman, 1980; Hakkanen, Puolakka & Santtila, 2004; Heath, Hardesty, Goldfine, & Walker, 1985; Santtila, Hakkanen, Alison & Whyte, 2003; Sapp, Icove et al., 1994; Snyder, 2008; Stewart, 1993; U.S. Department of Justice, 2001; Wachi et al., 2007;

Wooden & Berkley, 1984) . However, according to the most recent research, this might be changing again, as although most arsonists are male, the proportion of female arsonists is increasing (Burton, McNeil & Binder, 2012; Dickens et al., 2014).

With regard to other gender related characteristics, there is also some evidence that female arson offenders are generally older than their male counterparts and more likely to have a psychiatric diagnosis (Dickens et al., 2014). Also, male arsonists tend to have more varied criminal history (Dickens et al., 2014). However, there seems to be disagreement in the literature in relation to female criminal history. Thus, according to Stewart (1993), most female arsonists are likely to have a prior conviction for arson; however, Harmon et al. (1985) have reported that female arsonists commonly do not have a conviction for arson, rather they have convictions for assault. Dickens et al. (2014) also found that male arsonists more commonly have a history of alcohol abuse, and are more likely than female arsonists to be intoxicated at the time of the crime. Females are also less likely to stay and watch the fire compared to male arsonists (Dickens et al., 2014), and are more likely to have a history of sexual abuse compared to male arsonists (Noblett and Nelson, 2001; Puri, Baxter & Cordess, 1995).

Research also suggests that females are more likely to set fire to their own property, the property of a partner or other relatives, or more generally, targets well known to them (Bourget & Bradford, 1989; Burton et al., 2012; Harmon et al., 1985). Furthermore, Rengert (1975) found that female offenders are more likely to commit offences within their own neighbourhood, which could suggest not only familiarity with the area, but also the victim. Interestingly, some researchers have commented that familiarity and emotional ties to the target go well with revenge, which, as mentioned previously, has been identified as the most common motive for female arsonists (Bourget & Bradford, 1989; Harmon et al., 1985;

Stewart, 1993; Taylor, Robertson, Thorne, Belshaw & Watson, 2006). It appears, therefore, that gender may potentially be a key influence on arson related behaviours.

2.4.2. Age

With regard to age, Burton et al. (2012) found that late adolescence and early adulthood is the most common age category for the majority of arson offenders' firesetting activities. This is supported by a study in the USA which showed that about half of arson cases involved a young juvenile offender; of these offenders, 89 percent were males, 67 percent were under the age of 15 years old, and 35 percent were children under the age of 12 years old (Snyder, 1999). Also, Sapp, Hobert et al. (1994) found that 41.60 percent of the arrests for arson offences involved persons under the age of 18 years old, and 63 percent of offenders were under 25 years of age. Other studies have supported the view that arsonists tend to be very young; for example, in an early study Fineman (1980) reported that most fires were set by curious boys between five and 10 years old, and The Fire Watch Intervention Program claimed that the majority of arsonists are of pre-adolescent age (Braig & Whelan, 1995). Cox-Jones, Lubetsky, Fultz and Kolko (1990) also found a bimodal peak in the age of firesetters at eight and 13 years old. Moreover, in other studies, children as young as four, five and six years old have been identified as setting fires or being overly interested in fires (Dadds & Fraser, 2006; Kazdin & Kolko, 1986; Kolko & Kazdin, 1994; Kolko, Kazdin, & Meyer, 1985). In contrast, in Edwards and Grace's (2007) sample of 214 cases of arson, the mean age was 25 years old; so estimates can vary. Nevertheless, several studies have found that juvenile arsonists account for at least half of arson arrests (Hall, 2005; Hickle & Roe-Sepowitz, 2010; MacKay et al., 2006), and the literature generally seems to support the view that juveniles and young adults tend to predominate in arson offences. This may be particularly significant, given that the literature on criminal histories generally suggests that

the earlier the offenders begin their criminal careers, the more likely they are to commit further crimes, have longer criminal careers, and commit more serious and varied crimes (Blumstein, Farrington & Moitra, 1986; Elliot, 1994; Farrington et al., 1990; Gittens, 2011; LeBlanc & Loeber, 1998; Loeber & Le Blanc, 1990; Snyder, 1999; Tolan, 1987). There is also a general consensus that urban offenders are younger than rural offenders, as youngsters tend to be drawn towards urban areas and the opportunities they offer (Perryman, 2016). Notable also is that, compared with other serious criminals, such as serial murderers and rapists, arsonists are usually found to be younger. For example, Snook, Cullen, Mokros and Harbort's study (2005) found that serial murderers had a mean age of 28 years old at the time of their first murder. Another study by the U.S. Department of Justice (1997) showed that over 40 percent of rapists were 30 years or older at the time of their first assault. However, with regards to less serious crimes, such as delinquency, the mean onset age is more comparable with that of arson (18 years), and other studies even found onsets of delinquency down to eight years old (Blumstein, Cohen, Roth, and Visher, 1986; DeLisi, 2006; Patterson, Frogatch, Yoerger, & Stoolmiller, 1998; Tibbetts & Piquero, 1999). In other words, on the whole, the age profile of arsonists seems more similar to that of more minor offenders.

2.4.3. Family, Marital, Educational and Occupational Background

In general, the literature suggests that arsonists tend to have a number of adjustment issues. According to Burton et al. (2012), arson offenders tend to be unmarried and living alone at the times of the crime (see also, Geller, 2008; Sapp, Icové et al., 1994). Sapp, Icové et al., (1994) further found that, when married, arsonists are often found to have poor marital adjustment, whereas according to Snook, Cullen, Mokros and Harbort (2005) serial murderers are more likely to be married. Furthermore, female firesetters tended not to want children (Geller, 2008), whereas male firesetters in particular tend to be unemployed, and

show poor occupational adjustment (Burton et al., 2012; Geller, 2008; Sapp, Icové et al., 1994) and, if employed, they tend to be unskilled labourers (Burton et al. (2012). The employment status is again quite different from, for example, serial murderers who tend to have regular employment (Snook et al., 2005).

Looking at a sample of Finnish arsonists from 1970 to 1982, Eidsson (2005) concludes that the arsonists typically come from unstable backgrounds, and have experienced family troubles during their upbringing (i.e. characteristics which accord with some of the proposals of Functional Analysis Theory, such as for example poor caregiver relationships, self-loathing, depression, self-esteem issues, poor conflict skills and rejection from others). In support of the latter, Sapp, Icové et al. (1994) found that both male and female arsonists tended to come from dysfunctional homes. The family characteristics of the homes of arsonists have been shown to include lower levels of affectional expression, child acceptance and monitoring. Arsonists were also often placed outside the home and away from the biological parents during their upbringing (Kazdin & Kolko, 1986; Kolko & Kazdin, 1990). In further support of this, Hickie and Roe-Sepowitz (2010) found that 69 percent of their sample of arsonists reported unstable living situations and more than half (54 percent) had little or no contact with parents. Some of the unstable living situations found in this sample included a recent suicide attempt, death of a loved one, divorce, parental separation, and abuse incidents. Abuse (including physical, sexual and emotional) and neglect were reported by 20 percent of the sample (see also, Burton et al., 2012; Stewart, 1993; Tennent, McQuaid, Loughnane & Hands, 1971). Nevertheless, Santtila et al. (2003) found that 83 percent of their sample of arsonists were living with parents when committing the arson, reflecting the young age of the sample (see also Geller, 2008; Sapp, Icové et al., 1994). However, in many cases this might actually exacerbate any problems relating to dysfunctional backgrounds, particularly for females; for example, Geller (2008) found in his literature review that female

firesetters had a history of physical and sexual abuse, though this was not the case for male firesetters.

A number of studies have also suggested that more crime in general is committed by offenders from low socioeconomic status neighbourhoods with poor educational attainment (Lindstrom, 1995; Wikstrom, 1991) and that offenders residing in low income areas are more likely to continue offending for longer (Loeber & Wikstrom, 1993). For example, studies have found that as many as two thirds of incarcerated men had not graduated from high school (Freeman, 1996; Farrington, 1992; West & Farrington, 1973). Similar trends have been found with regard to arsonists. For example, Burton et al. (2012) found that most arsonists were of low socioeconomic status and were poorly educated, and Sapp, Icove et al. (1994) also report that arsonists tend to show poor academic performance, and have difficulties at school (see also, Eidsson, 2005). Moreover, in Santtila et al.'s (2003) sample, 83 percent were school pupils under 16 years old, and of them 70 percent had been in trouble in school. Relatedly, low intelligence has also emerged as an issue among arsonists, as well as the criminal community in general, according to several studies, which has obvious impacts on educational performance (Barron, Hassiotis & Banes, 2004; Jackson et al., 1987; Koson & Dvoskin, 1982; Lewis & Yarnell, 1951).

2.4.4. Ethnicity

With regard to ethnicity, Sapp, Hobert et al., (1994) found that 71 percent of arsonists were white, 24 percent were Black and one percent was of other ethnic background. Similarly, a study by the US Department of Justice (2011), using FBI statistics, showed that 72 percent of the arson offenders were white, 26 percent were Black and 2 percent were a mix of American and Alaskan natives or of Asian or Pacific origin. Also, in their sample of female firesetters, Hickie & Roe-Sepowitz (2010) found that the majority were of Caucasian origin, followed by

African American (Black) offenders and then a small mixed group containing offenders of Hispanic and other origin. Santtila et al. (2003) too found that an overwhelming 96 percent of arson cases were committed by white offenders. Interestingly, however, an early study, Berkey and Wooden (1984) found that, whereas arson was most often committed by middle class Caucasian males, other types of juvenile crime, such as theft, burglary and rape, were more often committed by lower-income non-Caucasian males.

2.4.5. Psychiatric History

In general, research suggests that mental illness is overrepresented among arsonists compared to the general population, and amongst some other categories of offenders, and that mentally ill firesetters tend to set more fires than mentally healthy firesetters (Burton et al., 2012). Moreover, offenders of both sexes are more likely to have parents who have a psychiatric history (Geller, 2008). For example, Burton et al. (2012) found that arsonists are 20 times more likely to have a diagnosis of schizophrenia than the general population. Yesavage, Benezech and Ceccaldi (1983) also found that 10 percent of all convicted arsonists had schizophrenia, and arsonists were four times more likely to have a psychotic illness compared to homicide offenders. Indeed, the disproportionate diagnosis of schizophrenia or other psychotic disorders amongst arsonists is well established in many other studies (see, for example, Bradford, 1982; Dejong, Virkkunen & Linnoila, 1992; Harmon et al., 1985; Hill et al., 1982; Koson & Dvoskin, 1982; Leong, 1992; Leong & Silva, 1999; Puri, Baxter & Cordess; 1995; Repo, Virkkunen & Rawlings, 1997; Repo & Virkkunen, 1997; Rix, 1994).

Several studies have also found that the incidence of personality disorders is higher among arsonists compared to the general population (Bourget & Bradford, 1989; Dejong et al., 1992; Harmon et al., 1985; Hill et al., 1982; Rix, 1994; Repo et al., 1997; Stewart, 1993; Taylor, Robertson, Thorne, Belshaw & Watson, 2006) and they often suffer from low self-

esteem (Stewart, 1993). Hence Burton et al. (2012) report that between 19 percent and 56 percent of the arsonists they studied had attempted suicide in the past and many had substance abuse problems (see also, Bourget & Bradford, 1989; Noblett & Nelson, 2001). Geller (2008) also found a high incidence of violence and alcohol issues amongst arsonists (see also, Eidsson, 2005). In addition, Burton et al. (2012) found that arson offenders were more likely to be socially introverted, isolated, and less assertive than other offenders.

Having considered some of the main demographic and biographical characteristics of arsonists in general, the next sections consider such characteristics in relation to two areas of research that reflect potentially important sources of individual differences in arson behaviour; solo versus co-offending, and single versus serial offending.

2.4.6. Solo Offending versus Co-offending

A number of demographic characteristics have been reported between arsonists who operate with others (group offenders) and those who offend alone (solo offenders). For example, Wood (2000) found that solo offenders of both genders were on average 12.80 years old, whereas group offenders were slightly younger on average, at 11.90 years old. This fits with a trend in the general literature on offending, where co-offending is most commonly found among youth offenders, coinciding with the onset of a delinquent or criminal career (Reiss & Farrington, 1991). Notably, these averages also fit with previous data that indicates arsonists tend to have the same age characteristics as delinquents, rather than perpetrators of crimes such as murder and rape. As Swaffer (1993) points out, youngsters who engage in arson are often engaging in other types of problem behaviour too, such as theft, breaking and entering, malicious damage, etc.; i.e. crime which is often minor and opportunistic by nature. Other research has indicated that peer pressure can influence engagement in deviant behaviour simply because of the individual's desire to fit into a group, which may be particularly strong

amongst adolescents seeking to form an identity (Costello & Hope, 2016). However, again results can be inconsistent. Hickie and Roe-Sepowitz (2010) found no significant differences in age (or race) between offenders committing the offence alone or in a group. Nevertheless, Hickie and Roe-Sepowitz (2010) did find that female juvenile offenders who committed arson alone, rather than in groups, were significantly more likely to come from an unstable environment; thus they were more likely to have had inconsistent caretakers and multiple places of residence. They were also less likely to be enrolled in school, more likely to be experiencing a crisis such as the death of a parent, recent divorce, being a victim of abuse, having a pregnancy or having had a recent suicide attempt. This fits with other data from Wood (2000) which suggest that group offenders were less likely than solo arsonists to be psychologically disturbed.

2.4.7. Serial versus Single Offenders

Definitions of serial offending in criminal behaviour generally, have varied; though they tend now to refer to two or three offences, with a cooling off period in between (Hicks and Sales, 2006). Hence definitions such as those of Holmes and Holmes (1998), who describe serial killing simply as having three or more victims, tend now to be rejected or modified, because a cooling off period is deemed necessary to differentiate serial offending from 'spree' offending (Hicks & Sales, 2006; Ressler, Burgess, & Hartman, 1986). In the same way, Turvey's (2002) definition of serial arson as involving two or more related cases involving firesetting behaviour, has been modified by the FBI to one which defines serial arson as an offence committed by firesetters who set *three* or more fires with a cooling off period in between fires (U.S. Department of Justice, 2011). In contrast, in their 2014 study, the U.S. Department of Justice defined a serial murderer as a single offender who killed at least *two* victims in separate events at different times; i.e. serial offending concerns two or more targets

not three or more, and requires only that the events are separated in time. Clearly then, a definition of serial arson offending presents problems both conceptually, in terms of developing a meaningful rationale for differentiating between serial and spree offending, and methodologically, in terms of developing cut-off points for defining what constitutes a ‘cooling off’ period. Given these issues, in the present thesis, a serial arsonist will be defined simply as any offender who has set fires on *two* or more separate occasions.

A significant number of studies have compared serial and single (one time or occasion) offenders on the demographic variables discussed earlier. These have shown that there is broadly no difference between serial and single offenders on a variety of variables. For both single and serial arsonists, the majority of offenders are male, often suffer from mental health problems, have previously attempted suicide, are poorly educated, have been in trouble in school and have a history alcohol abuse issues. It is also not unusual for both single and serial arsonists to have been placed in foster homes at some point during their upbringing (Sapp, Hobort et al., 1994). In addition, both single and serial offenders tend to be White Caucasian (Edward & Grace, 2007; Sapp, Hobort et al., 1994; U.S. Department of Justice, 2014).

However, some differences have been reported. For example, serial offenders have been found to be older (e.g. Edwards & Grace, 2007; Sapp, Hobort et al., 1994; Waschi et al., 2007). Also, a few studies have reported that serial arsonists are more likely to be in long term relationships or married (Sapp, Hobort et al., 1994; Waschi et al., 2007), have a stable employment history, and claim to come from stable homes (Sapp, Hobert et al., 1994). Finally, although many single arsonists have a criminal record, this often excludes firesetting behaviour (Burton et al., 2012), whereas the majority of the serial arsonists have a history of multiple arrests, the most common being for arson (Sapp, Hobert et al., 1994).

Interestingly, an American study carried out by the U.S. Department of Justice (2014) found that, like arsonists, many serial murderers (who used other methods) had mental health issues and abused drugs and/or alcohol; however, these serial murderers tended to be better educated than arsonists.

2.5. Geographic Profiling

Clearly there has been a large amount of research on demographic and biographical correlates of arson; however, even if we ignore inconsistencies, it is apparent that the results have not been sufficiently integrated and elaborated with other findings to allow a detailed description of the profiles of arsonists and their behaviour. However, one approach mentioned briefly earlier, that has attempted to evolve a systematic behavioural method for more accurately profiling the behaviours of arsonists is geographic profiling.

2.5.1. Geographic Profiling: Basic Concepts

Geographic profiling is a criminal investigative methodology that analyses the locations of the crime scene to determine the most probable area of offender residence based on concepts such as distance decay and buffer zone. The aim is to aid the police by narrowing down the number of suspects to those living in a particular area where the offender is most likely to reside. It has reportedly been used with success with a variety of crimes including murder, rape and, most important here, arson (Canter & Larkin, 1993; Le Comber et al., 2006).

Within the terminology of geographical profiling, a buffer zone is the area immediately around the offender's home, where he or she does not commit crime for fear of being recognised as a familiar face. Beyond the buffer zone, distance decay assumes that offenders will tend to commit crimes in relatively close vicinity of their home, i.e. within their 'activity space', because travel requires time, money and effort, and it is more difficult for the offender

to retreat to his or her comfort zone (Canter & Larkin, 1993; Le Comber et al., 2006). A variety of research appears to support the idea that most serial offenders, in particular, tend not to travel far from their home base when committing offences (see for example, Brantingham & Brantingham, 1981; Canter & Larkin, 1993; Lebaeu, 1987). Hence proponents of this approach propose that a serial offender's home base can be located by plotting the crime scene locations on a map, as the offender's home base will be at the centre, or at least in close vicinity, of the majority of the crime scene locations (Canter & Larkin, 1993).

2.5.2. Journey to the Scene of the Crime

Trotta (2012) argues that geographical profiling can also make use of barriers which offenders, as well as the general population, do not often cross. The barrier is perceived as an obstacle which makes the distance between A and B longer than it really is. These specific barriers will influence the distance decay function. The barrier will also vary depending on the means of transportation for the offender. For example, for the pedestrian the highway is a barrier, whereas for an offender in a car the highway is easily managed.

A related feature of geographical profiling, concerns the concept of the offender's travel journey to the crime scene, which is assumed to follow certain patterns for different individuals and criminal behaviours. For example, in a study by Meaney (2004) on 136 Australian serial offenders, it was found that burglars were more likely to use a 'commuter' offender style, offending further away from home, than non-burglars, whereas arsonists and sex offenders were more likely to use a 'marauder' offender style, traveling less distance from home.

A further elaboration this approach is Canter and Larkin's (1993) circle theory. They propose that a circle drawn from the two outer most crime scenes will contain the offender's

home base in around 87 percent of the cases. The theory has been applied, in particular, to the crime of arson, as well as rape and murder, and has received some support (Canter & Larkin, 1993; Kocsis & Irwin, 1997; Kocsis, Cooksey, Irwin & Allen, 2002; Lundrigan & Canter, 2001). In fact, Canter and Larkin (1993) found support for two circles, termed a 'criminal range' circle and a 'home range' circle. The home range circle was the immediate area around the offender's home base (like the concept of the buffer zone), whereas the criminal range was further away from the offender's home. Accordingly, Canter and Larkin argue that the inner circle represents the offender's non-criminal activity zone, whereas the criminal range is where the offender can commit crimes within a safe distance from the home base, but not too close to be recognised by neighbours.

Travel distance may also depend on the motive behind the arson. For example, Sapp, Hobert et al. (1994) report that vandalism arsonists set fires within 0.8 and 1.6 km from their home or workplace, whereas arsonists motivated by revenge set fires between 1.6 and 3.2 km from home or workplace, as did arsonists who were trying to conceal another crime with arson. Fritzon (2001) also found support for connecting motive and travel distance in a study of 156 solved arson cases. The overall mean for Fritzon's sample was 2.1 km from home to crime scene (range 0 to 116.2 km). However, Fritzon found that when the firesetting was associated with instrumental gain and crime concealment, the mean travel distance was 2.1 km; whereas if the firesetting was done as attention seeking behaviour or for recognition (setting the fire and discovering it), the mean travel distance was only 0.5 km. Also, if the firesetting was apparently an act of despair, and due to emotional distress, the mean travel distance was again short at 0.6km. In contrast, if the firesetting was conducted for revenge, or generally as a planned attack against a specific person, the mean travel distance was longer at 6.3 km. The possible reasons for this seem fairly obvious; if the action is out of despair (impulse), or for recognition or attention, one might expect offenders to commit crimes closer

to home; however, if the target is revenge or is planned, the crimes will most likely be specifically targeted to where the object of the attack is located, and where identity of the perpetrator can best be concealed.

However, in overall terms of travel distance, arson appears similar to other types of less serious crime. For example, according to Harling (1972), the mean travel distance for drug offences is 3.5 km, theft 2.9 km, burglary 1.2 km and vandalism 1 km. The fact that, on average, these crimes tend to have relatively short travel distances, fits with other results reported earlier, suggesting that such crimes are very often committed by young people, and are more likely to be opportunistic and committed in the spur of the moment, fuelled by anger, frustration or boredom etc (Grant & Kim, 2007).

2.5.3. Geographic Profiling: Problems and Issues

Notwithstanding these findings, the geographical profiling approach is not without its problems. For example, in a study of 45 serial arson offenders from New Zealand, Edwards and Grace (1993) found that the circle theory provided only limited information for predicting the home base of the offender in that the offender's home base was not in the middle of the home range as predicted by Canter and Larkin. Additionally, only 50 percent of the offenders matched the criteria of the circle theory (see also, Edwards & Grace, 2007). Other research specifically on arson suggests the serial arsonist's travel distance depends on age and gender. As noted previously, there is some evidence that arsonists tend to travel a fairly short distance from home base to crime scene; however, within this boundary, work cited by Wachi et al. (2007) found that males in their thirties travelled the longest distance, whereas the female serial arsonists more often set fires closer to home.

A variety of studies concerning other crimes (i.e. not arson) have thrown up a number of other inconsistencies in predictions from geographic profiling principles. For example,

although there seems to be general agreement that most rapes occur within 8 km of the rapist's home (Fritzon, 2001; Nichols, 1980; Phillips, 1980; Warren et al. (1998), there appears to be wide variation in travel distances for rape. For example, in a study of 320 rapists, Lebeau (1985) found an overall mean distance of 4km between the home base and crime scene location. However, Davies and Dale (1995) found even shorter travel distance for rapists i.e. 29 percent of rapes occurred within 1.6 km of the rapist's home, and 51 percent of rapes occurred within 3.2 km of the rapist's home. Warren et al. (1998) also found racial differences in travel distance, as White offenders travelled further distances than Black offenders. There appears to be some consistency for age, as Rhodes and Conly (1981) found that older rapists travelled further than younger rapists, and similar results have been reported by Fritzon (2001) and Phillips (1980). However, results seem contradictory for gender. Hence Phillips (1980) found that, in general, female offenders travelled longer than male offenders, whereas other studies have found the opposite (see Fritzon, 2001). Also, whereas Pyle (1974) found that rapists travel shorter distances than robbers and burglars, Rhodes and Conly (1981) found a similar travel distance for all three groups.

Because of the limited amount of research that has been conducted specifically on the application of geographic profiling to arson, it is difficult to know whether similar problems might occur with regard to a more detailed examination of arson related crimes. However, there are a number of other reasons why it might be useful to look to a different kind of approach when studying arson.

2.6. Conclusion: Investigating Arson from a New Angle

According to Canter and Almond (2007), the first stage in developing a strategy for dealing with arson is to identify the various forms of arson and arsonists. As noted earlier, classifications so far have mainly been derived from considerations of motivation. However,

despite its popularity, motivation is a fairly nebulous, hypothetical construct that has to be inferred by the investigator from other forms of observable behaviour; it may also change according to place and situation (Almond et al., 2005; Canter and Almond, 2007; Gannon & Pina, 2010). Given this, to date, perhaps the most promising attempt to evolve a systematic, behavioural method for more accurately profiling the behaviours of arsonists has been geographic profiling. However, as we have seen, results are not always consistent, and one of the obvious reasons for this is that travel distances are influenced by a host of factors, including environmental influences, many of which have yet to be identified.

One way of improving the accuracy of profiling approaches, therefore, might be to adopt a more ecological approach. It seems likely, for example, that inconsistencies in findings relating to travel distance are due, not simply to measurement error, but to other local factors that have not been considered (Edwards & Grace, 2007; Rossmo, 2000). Thus, rather than expecting travel distances to be consistent from sample to sample and from country to country, it might be useful to use smaller research units. For instance, the street environment can change within a couple of kilometres, let alone from country to country; as such, travel distances might be different in an rural setting with small, quiet and intimate streets, as opposed to an urban setting with large intersections and noisy traffic. Urban environments may also present more opportunities for arson attacks nearer to home. In this respect, Burton et al. (2012) report that arson is now twice as common in urban areas as opposed to rural areas and there are a number of indications that arson may be still changing from what was previously a rural crime to an urban crime (see, for example, Burton et al., 2012; Wachi et al., 2007). Consequently, a new approach to the study of arson that complements and elaborates demographic, biographic and geographic information by including a finer level of environmental and other detail might be potentially more flexible and responsive with regard to the effects of different and changing factors in the

environment. In the next chapter some ideas that may facilitate this are introduced and discussed.

Chapter 3

Crime Prevention Through Environmental Design (CPTED) and Defensible Space Theory: Towards a New Approach

3.1. Introduction: An Environmental Approach

As noted in the previous chapter, with the exception of geographical profiling, research into the environmental correlates of arson has so far been very limited. Although geographical profiling research has previously had some reported success in predicting correlates of a diverse set of crime types, results have been inconsistent, and what results have been found specifically in relation to arson, do not necessarily fit the predictions of the theory (Edwards & Grace, 2007). It was suggested, therefore, that one possible way forward would be to adopt a more detailed ecological or environmental approach to studying arson that incorporates a finer level of environmental detail in the prediction of arson; i.e. an approach that looks more specifically at features of the environment that may influence where arsonists tend to set fires as well as why and how they navigate their environment. Therefore, one of the aims of the present thesis is to help to develop a framework for providing a broad based understanding of which features and types of neighbourhoods attract fire setting behaviour and why.

As a way of providing a possible conceptual basis for this, this chapter describes and explains two theoretical approaches from environmental psychology, and some related concepts, which have yet to be applied systematically to the study of arson; Crime Prevention through Environmental Design (CPTED) and Defensible Space theory.

3.2. CPTED and Defensible Space Theory

Manipulating human behaviour through the environment is by no means a novel concept. Architects have used designs of buildings and space management concepts to influence human behaviour and navigation in the environment for more than 5000 years (Crowe, 2000). However, although attempts to manipulate the environment to reduce crime have a long history, very little empirical research has been carried out on a community level (Anderson, MacDonald, Bluthenthal & Ashwood, 2013). Two approaches, however, that have been shown to be promising in this respect, are Crime Prevention through Environmental Design (CPTED) and Defensible Space theory.

Crime Prevention through Environmental Design (CPTED) is based on some fairly standard concepts adopted from environmental psychology; the term CPTED being originally coined and the theory formulated by criminologist Ray Jeffery in 1971. Defensible Space Theory was at the same time developed by architect, Oscar Newman (1972). Both built their theories on the previous work of researchers such as Wood, Jacobs and Angel during the 1960s (see Crowe, 2000). In detailing the theories, it may be useful to start with defensible space theory.

3.3. Defensible Space Theory

Defensible Space Theory encompasses a number of ideas about crime prevention and neighbourhood safety in an urban environment. Newman (1972) suggests that lower crime rates may be achievable through community architectural design and, in particular, the establishment of defined defensible space, which he says is, "a term used to describe a residential environment whose physical characteristics—building layout and site plan—function to allow inhabitants themselves to become key agents in ensuring their security" (Newman, 1972, p.3). A defensible space is also an area in which inhabitants, as well as

guests and strangers, perceive that the area they have just entered is occupied, guarded and safe, and that it is appropriate to question a stranger's presence in the midst of the local community. Hence, in areas where there are high defensible space characteristics, inhabitants feel they have more control over their environment, feel more responsibility for it and their co-inhabitants, and, in particular, feel safe (Crowe, 2000; Schneider & Kitchen, 2002). The desire for safety is even proposed by Maslow as a most basic human need (Maslow, 1970). Moreover, by definition, if people feel that their environments are safe, the same cues may have a deterrent impact on those who might threaten this safety.

Newman's principles of Defensible Space theory were largely derived from a large study he conducted in 1972 of high and low rise buildings. The study was carried out on the Brownsville and Van Dyke projects, which were chosen because although they were strikingly different in terms of physical design, they housed identical populations in size, as well as social characteristics. Both projects were inhabited by approximately 6000 people, and had exactly the same housing density of 288 persons per acre. The main differences were in the arrangement of the buildings and the percentage of ground level space they occupied. According to Newman, the Van Dyke project had basically no defensible space characteristics, largely because it was high-rise, whereas Brownsville had several defensible space qualities, mainly because it was low-rise (although it was still not anywhere close to satisfying all defensible space directives). The two projects were situated across the street from each other, and shared the same police services.

Significantly, Newman found that higher crime rates existed in the high-rise apartment buildings than in the lower-rise housing projects and argued that this was at least partly because, in the Van Dyke project, residents felt no control over or felt no personal responsibility for their environment or its occupants. Indeed, crime rates were found to increase proportionally with building height; thus, for a three story building the crime rate

was nine per 1000 head of population, whereas for 16 stories or more the crime rate rises to 20 per 1000 (Newman, 1972). Newman argued that this might also be the case with other buildings that attract many people on a daily basis, such as public buildings (for example, municipal buildings, libraries and hospitals) and entertainment buildings (for example, bars and movie theatres). Newman (1972) also identified a variety of other architectural and environmental features that appeared to influence crime rates; for example, significant reductions were found for lobby crime and muggings in the housing projects where the entries faced the street rather than the interior ground. Also, crime rates were lower when the buildings had a doorman and there were fences surrounding the property (Newman, 1972). However, other research has found mixed results; for example, McDonald and Gifford (1989) found crime rates were higher where properties did have fences.

In addition, Newman (1972) noted an interaction between architectural features and the characteristics of the occupant populations. For example, he suggested that, before the 1960s, high-rise buildings had, in the main, worked well. However, in the past they were occupied by a very different kind of population; that is, by small, high income families, whereas, at the time of the study, high-rise buildings were mainly occupied by large low income families who might be more prone to offending. He also suggested that new generations brought up in this kind of anonymous residential environment might not develop the same sense of collective space and community responsibility as those in other developments (Newman, 1972; see also, Crowe, 2000).

Largely as a result of this study, Newman concluded that there are four main factors which make up a defensible space and, therefore, may significantly affect crime rates. The first is 'territoriality' which is the idea that a person's home is sacred and is their territory, as well as their responsibility. In other words, the resident has to extend the feeling of responsibility to beyond the boundaries of their own living unit. A particular problem arises,

however, when an area is perceived as neither public nor private as then there is a danger the area may effectively become a no-man's-land. In such cases, the boundaries have to be exclusive and inclusive at the same time, which is a difficult balance to establish; i.e. there have to be clear boundaries between the private and public spheres, but, at the same time, the boundaries of the private sphere must not completely exclude the outside world and nearby community. Newman argues that this may be a particular problem with high rise buildings which tend to have more communal areas.

The second factor is 'natural surveillance' which concerns an area's physical characteristics and if they are shaped in such a way that the residents have the ability to see what is happening. For example, a type of natural surveillance would be if the dwelling windows allow the residents a natural way of surveying their own environment as well as exterior and interior areas, with no or very few closed and available hiding places. Big high-rise buildings are generally very visible externally, but their interiors are largely hidden from public view. Natural visual surveillance could be improved by adding certain design features to buildings so that the residents could more easily perceive and control the activities which take place within their community, and intruders may be deterred; for example, glassed fronted stairwells, and visible outward facing entrances.

The third factor that makes up defensible space is 'image'. This is the capacity of the physical design to impart a sense of security in the form of special features of the building to make it stand out as individual. Newman (1972) argues that high-rise buildings often end up anonymised and may become an attraction for criminal behaviour if not designed with special features to make them stand out as in a positive way; buildings that are more individualised are also more likely to encourage territoriality (Donnelly, 2010).

The final factor of defensible space proposed by Newman is 'milieu' which concerns other environmental features that may affect security, such as proximity to a police substation

or busy commercial area (Newman, 1972). For example, buildings that are closer to police stations may be more likely to evoke a sense of security amongst occupants, and make potential offenders feel more likely to be apprehended.

In its early years, Newman's Defensible Space was criticised for focusing too strictly on architectural determinism and the efficiency of symbolic territorialism. However, later Newman acknowledged that other social variables might influence crime rates and residents' views, so many of Newman's ideas subsequently became incorporated into Jeffery's more wide ranging theory of Crime Prevention through Environmental Design (Jeffery, 1971; Newman, 1996).

3.4. Crime Prevention Through Environmental Design (CPTED)

Crime Prevention Through Environmental Design (CPTED) is a strategy and a set of concepts that offer guidelines on how to design the environment to manipulate the user and, thereby, evoke desired behaviours in the residents of a neighbourhood, as well as *guests* (wanted as well as unwanted ones). According to Crowe (2000), CPTED "...does not purport to develop crime prevention solutions in a broad universe of human behaviour but rather solutions limited to variables that can be manipulated and evaluated in the specified human/environment relationship" (p. 35). Accordingly, CPTED is based on an opportunity model in relation to the offender's behaviour, which assumes that their behaviour can be explained by how variables in the environment interact to induce crime. Thereby, CPTED attempts to integrate natural approaches to crime prevention with building design and neighbourhood planning (Crowe, 2000).

As noted previously, the foundations CPTED and Defensible Space theory are very similar, hence Newman's basic principles still exist in CPTED, but the latter focuses more on

the influence of social variables and the detailed makeup of the immediate and nearby environments.

3.4.1. Access Control and Territorial Reinforcement

There are three main strategies in CPTED; natural access control, territorial reinforcement, and natural surveillance. However, these are not to be thought of as independent; rather they should be construed as integrated and overlapping (Crowe, 2000).

Access control mainly addresses crime opportunity. Strategies used to minimise crime opportunity can include, for example, the use of guards, or doormen, which would be classified as an organised access control. It can also involve putting on locks (classified as mechanical access control) or making clearly defined spatial areas (natural access control).

A major part of CPTED, therefore, concerns the manipulation of physical features to provoke a sense of territorialism in community members, in the hope that this will lead to a safer living environment for those that use it. A territory is usually defined as a relatively stationary area, which is marked by the individual occupying the territory (Bell, Green, Fisher & Baum, 1996). As such, territory can be a fixed place like one's home, but can also be on a less permanent set-up like a chair in a public place, territorially marked by a jacket or a book, for example (Altman, 1975; Brower, Dockett & Taylor, 1983; Edney, 1972; Fisher & Byrne, 1975; Taylor & Brooks, 1980). According to CPTED, housing developments that evoke territorialism constitute one of "the strongest deterrents to criminal and vandal activity" (Newman, 1996, p.29). Indeed, low crime rates have been linked to successful territorial functioning in a number of studies (for example, Abdullah, Marzbali, Bahauddin, & Maghsoodi, 2012; Bennett & Wright, 1984; Brown & Altman, 1983; Newman, 1972) and some studies have even suggested that residents are less likely to become victims if they make use of territorial markers (Perkins, Wandersman, Rich & Taylor, 1993; Weisel, 2002,

2004). Relatedly, it has also been suggested that when territory is less established the level of violence increases (Ley & Chybriwsky, 1974).

CPTED proposes, therefore, that, through appropriate functional design that encourages territoriality, people should not only feel comfortable questioning what is happening in their surroundings, but they should feel obligated to do so. Moreover, this applies not only to their immediate property but also connecting streets and surroundings. In facilitating the latter, the intent in CPTED is to give the residents of a particular community effective control of public spaces that they may otherwise feel are out of reach. In effect, therefore, residents should be encouraged to care enough for their neighbourhood area to protect it from crime, as they would protect their own private property. As a result, criminals may fear that there is a high likelihood that any resident, upon viewing an intrusion, would question their actions. This is deemed to be a highly effective deterrent in neighbourhoods that cannot afford a professional crime watch (Crowe, 2000; Newman, 1972, Newman, 1996).

As referred to earlier, according to CPTED, one particular effective way of encouraging territoriality, and discouraging intrusion, is through the use of territorial markers. It is generally known that no matter for how long a person plans to stay in one place, they tend to make some sort of attempt to mark the territory and personalize the space. Humans frequently express a need to establish both temporary as well as a more permanent ownership of a space they occupy. For example, they may put shirts, jackets and suits on hangers in a hotel room to personalize the room or they may put down personal markers in or in front of a home. Consequently, in accordance with Altman's theory on human territoriality (1975), depending on the markers used, and how clear they are displayed every space can be classified on a range from private to semi-private to semi-public to public (Crowe, 2000).

A variety of evidence supports the idea that territorial markers may reduce crime; indeed, defensiveness with regard to primary territories has been shown to increase with the level of territorial markers (Ley & Chybriwsky, 1974). For example, Bell et al. (1996) found that, when there is a clear boundary between spaces and they obviously belong to someone, there is less crime and vandalism. Bell et al. (1996) found that both actual barriers (for example, hedges and fences) and symbolic barriers (for example, clearly marked grass area, small stones to mark the boundary between private and public territory) can have an effect in this respect and appear to make the home less inviting for burglary. Signs of occupancy can also have an effect; a home stripped of personalised effects is more likely to be targeted.

However, other research has been less supportive. For example, Bennett and Wright, (1984) found no support for the idea that territorial markers can be a deterrent for burglary. MacDonald and Gifford (1989) also found that houses with territorial markers were not less targeted than houses with territorial markers. Indeed, it appeared that, at times, burglars would assume that well-kept homes would have more valuables in them. Macdonald and Gifford (1989) suggest that such contradictory results may reflect the difficulty in determining appropriate territorial markers or confounding by other variables.

To encourage territoriality and create a defensible space community, CPTED also proposes that residential areas should be subdivided into smaller entities. The argument is that territoriality and a sense of territoriality are more easily assumed when residents are in smaller groups. Smaller groups tend to use areas designated for and geared towards them more frequently thus the number of activities in the space is increased, and a feeling of ownership and a need to protect the property follow. Alternatively, when larger groups use a community space, no-one, or no group, has obvious control over the area and an agreement over its acceptable uses is often in dispute, leading to lesser feelings of ownership and, correspondingly, less desire to protect the property (Crowe, 2000).

With regard to surveillance aspects, CPTED proposes that the juxtaposition of dwelling interiors with exterior spaces and the placement of windows should be designed to allow residents to naturally survey the exterior and interior public areas of their living environments. Furthermore, the entrances and amenities associated with high-rise buildings should be positioned next to city streets, so that the streets fall into the sphere of influence of the residential environment. Smaller groupings in smaller defined spaces also make surveillance easier, thus discouraging crime (Crowe, 2000).

3.4.2. Users of an Environment

In addition, CPTED also considers users. The approach focuses on three kinds of users; the normal user, for whom the space was designed (most often residents), the abnormal user, for whom the space is not designed (strangers) and the observer, who are people who have to be in that particular space to support the function of the area (for example, police) (Crowe, 2000). The strategies incorporated in CPTED can be aimed at only one or two kinds of possible user of an area or all three possible types of users. Most important, a condition that makes the normal user feel safe (such as natural access control) could make an abnormal user experience a risk of detection (Crowe, 2000). Thus, environmental cues that signal a safe environment for one type of user will usually signal the opposite for another type of user.

Environmental cues can also be of high importance in residential areas; they can reflect the extent to which *owners* of the area are prepared to protect their area. For example, clean gutters and decorations can indicate that owners are proud to live there and that they care about their area. In contrast, undrawn curtains, untidy lawns and sidewalks could signify residents who are not engaged with or have little investment in their community (Crowe, 2000). Similarly, other studies have indicated that features such as untended property,

abandoned cars and high levels of theft in an area may send signals that no-one cares about the area which could then attract criminal behaviour (Bennett, Merlo & Leiker, 1987).

3.4.3. The Application of CPTED to Environments

Features proposed by CPTED are, in principle, applicable to any type of planned space. Thus, whether applied to low- or high-rise housing, or areas with high and low population and building density, the key is the development of a communal area from which residents can extend the realm of their own homes and feel responsible for other areas of the development. Several case studies have demonstrated how CPTED can be effective in reducing the incidence of crime, and fear of crime in many different types of area including convenient food stores, malls and shopping centres, transit stations and parking structures (for example, Cozens, Saville, & Hillier, 2005; Fisher & Piracha, 2012; Smith & Bise, 1998). One such case study, outlined by Crowe (2000), reports that neighbourhoods in Fort Lauderdale, Tallahassee, Knoxville, Jacksonville and Toronto have implemented CPTED concepts in their communities and have experienced major reductions in drug sales, burglaries and general crime. Crowe notes that a number of convenience stores have also used CPTED to increase sales and reduce losses from theft by up to 50 percent and robberies by up to 65 percent. The latter is significant since robberies tend to involve a higher degree of planning and, thereby, offenders may tend to make more use of environmental features and cues. One of the largest malls in the world, in West Edmonton, Alberta, Canada, has also used CPTED concepts with well-documented success including a significant reduction in criminal incidents. In addition, Crowe (2000) reports studies where CPTED concepts have been incorporated into the design of office environments, commenting that features which encourage territoriality in the office environment can increase morale and productivity in staff as well as lower the tolerance of dishonesty among colleagues.

3.5. Other Influences related to Defensible Space Theory and CPTED

The above review considers the main tenets of Defensible Space Theory and CPTED in providing a rationale for the empirical work in this thesis. However, in this context, it may also be worth considering other potentially related approaches to studying arson that may relate to, and elaborate on, some these concepts.

3.5.1. Incivility Theory

According to CPTED, particular environmental cues within residential areas will influence how much owners of the area are prepared to protect it. As noted, such cues can include clean gutters and decorations, drawn curtains, tidy lawns and sidewalks (Crowe, 2000). In this respect, there are obvious overlaps between CPTED and some of ideas encompassed by Wilson and Kelling's Incivility Theory or Broken Window Theory (1982).

Incivility theory is concerned with how signs of civil disorder may affect surroundings and subsequent reaction to them. As part of this, Wilson and Kelling (1982) propose that both visitors and residents are more inclined to commit serious crimes in neighbourhoods that appear to be deteriorating, both physically and in terms of social structure, as local residents will tend to withdraw when incivilities occur in the neighbourhood. This could also be considered to fit with Functional Analysis Theory, which states that firesetting is facilitated by an interaction between internal and external triggers (Jackson, Glass & Hope, 1987; Sturme, 2008). As such a socially deteriorating structure in a neighbourhood might escalate crime rates even more if the neighbourhood is not well maintained and the result is a vicious spiral that encourages more crime. Wilson and Kelling (1982) initially based their theory on a classic study by Zimbardo (1969), with two cars abandoned in two different neighbourhoods. Zimbardo (1969) found that the car left abandoned in a working class neighbourhood was quickly targeted and vandalised, whereas

the car left in a more affluent neighbourhood was left untouched for a week. Zimbardo concluded that people are more likely to participate in destructive behaviour on property that they believe no one cares about, as opposed to property considered to be valued (see also, Petersen, 2004). Interestingly, following Zimbardo's study, many American police departments passed laws on loitering, drinking in public and urinating on public as a part of their defence against crime (Winters, Globokar & Roberson, 2014).

Accordingly, Wilson and Kelling (1982) report evidence that high crime is more frequent in neighbourhoods with extensive visible deterioration. This is not necessarily visible damage per se, or deterioration of homes in general, that is the major problem, rather the issue concerns whether the damage and deterioration are not fixed within a relatively short period. If not, this sends a signal to the residents in the neighbourhood that other residents do not care and this, in turn, may imply social disorganization, leading to fewer 'eyes' on the street, and, consequently, less surveillance and more crime. According to Wilson and Kelling, therefore, any indication of the lack of caring such as unfixed broken windows, vacant properties, weeds growing or graffiti may lead to a breakdown of control in the local community. Indeed, as a result of these factors, over a short space of time, a neighbourhood can go from being a 'stable' neighbourhood to one where unwanted intruders come in and criminal activity increases. These then can be accepted as 'normal'. In short, Incivility Theory suggests that targeting minor disorders and deterioration in a neighbourhood can help prevent more serious crime activity. More recently, Austin, Furr and Spine (2002) have reported that there is a negative relationship between the number of properties targeted by criminals and exterior maintenance, supporting the view that houses with poor maintenance are considered less defensible and more prone to crime than others (see also, Lindenberg, 2012).

Notwithstanding this, however, Abdullah et al., (2012) have argued that the physical features of the environment alone cannot account for why some neighbourhoods have high crime rates and others have low crime rates (see also, Harcourt & Ludwig, 2006; Sampson & Raudenbush, 1999). Hence, Wilson and Kelling (1982) have argued that deteriorating neighbourhood environments do not necessarily lead to increases in crime, rather they only increase the likelihood of crime occurring. However, like with Defensible Space Theory and CPTED Theory, there do not appear to have been any studies that have looked specifically at arson from the perspective of Incivility Theory.

3.5.2. Population Density and Crowding

Another factor touched on, but not really developed by Defensible Space theory and CPTED, is population density. To encourage territoriality and create defensible space communities, CPTED proposes that residential areas should be subdivided into smaller entities, so that territoriality and a sense of communal responsibility are more easily achieved when residents are in smaller groups. If this is expanded to community levels, population density may have an influence on crime levels; that is, areas of low population density would be less likely to have as many crimes per capita as high density areas. Indeed, this topic has long been a source of study in its own right, with the suggestion that density and overcrowding are among the factors directly or indirectly contributing to crime by reducing social control and/or increasing strain (Agnew, 1999; Coleman, 1990; Wirth, 1938).

Much of view that ‘crowding’ associated high density populations can have adverse effects on health and behaviour initially arose from animal work that was subsequently generalised to humans (see, for example, Dyson & Passmore, 1992; Judge & deWall, 1993; Peace & Patterson, 1993). Research on humans has shown that even physiological variables, such as blood pressure and pulse rate can be affected by high density conditions (Cox, Paulus

& McCan, 1984; D'Atri, Fitzgerald, Kasl & Ostfeld, 1981; Wooldredge & Winfree, 1992). Studies supporting the idea that high density is associated with high crime rates in humans suggest, for example, that, in high density areas, residents tend to like others less than in low density areas (Bell et al., 1996). People may also be more likely to use withdrawal as a coping strategy when living in high density areas (Bell et al., 1996) and are less likely to seek help from authorities (Evans & Lepore, 1993). These factors may all negatively affect crime rates in particular areas. Other studies suggest that population density may adversely moderate other effects, such as the relationship between territorial markers and victimisation. For example, what in some places might function as a territorial marker (jacket over a chair in the local café), might, in other settings (for example, airports and train stations) be likely to be stolen (Bell, Green, Fisher & Baum, 1996).

Nevertheless, high density situations are not always perceived as negative and there can be cultural differences; for example, Aiello and Thompson (1980) found that, given the opportunity, Chinese people will tend to choose high population density housing over low density housing. The authors suggest that this is because, historically, Chinese may be more familiar with high-density housing. In addition, some studies have found that population density, housing quality, and overcrowding are not predictors of crime (Choldin, 1978; Wilner, 1962). Moreover, Bell et al. (1996) point to a number of complexities in the findings; for example, although high density housing appears to be associated with increases in violent crime in males, it does not for females, and even then, the relationship appears to be curvilinear, such that males are more aggressive in both very high and low density housing areas. One is reminded here perhaps of the classic Yerkes-Dodson curve between performance and arousal (Yerkes and Dodson, 1905); that is, it is possible that at low levels of density/arousal males may be prone to becoming aggressive because of boredom and lack

of stimulation, whereas at high levels they may become uncomfortable and frustrated and need to 'vent' these feelings.

It also seems that the presence of other people can have both a criminal preventive effect and criminal encouraging effect. For instance, according to Lindenberg (2012), if there are cues in the environment that the environment is respected and valued, then people are more likely to act in a helpful way, and this may have a contagious effect. For example, there is evidence to suggest that, if a person is in need of help, bystanders are more inclined to help if there are other people present who indicate that they are also willing to help (Rutkowski, Gruder, & Romer, 1983). It is possible, therefore, that a perception of this effect may discourage some potential offenders in high density environments in which others are more likely to be present. High population density might also discourage offending by increasing opportunities for surveillance; correspondingly, the absence of people in empty places such as parking garages, office buildings at night, and empty streets, may increase the risk of socially unwanted and deviant behaviour (Lindenberg, 2012).

However, whatever the case, given the above, it would clearly be useful for any study investigating the correlates of arson to include some measure of population density.

3.5.3. Urban Versus Rural Crime Rates

Closely related to population density and crowding are the different characteristics of urban and rural areas which may also have a potential influence on the behaviour of arsonists.

According to Unicef (2012), the definitions of the concept 'urban' can differ from country to country, and even within a country at one time or another. However, a generally accepted definition is that of Weeks (2010), who defines 'urban' as "a place-based characteristic that describes the degree to which the lives of a spatial concentration of people are organised around non-agricultural activities" (p. 43). A useful definition of rural is harder to find, but is

commonly defined in ways similar to that of the U.S. Census Bureau (2016): i.e. “what is not urban—that is, after defining individual urban areas, rural is what is left” (Ratcliffe, Burd, Holder & Fields, 2016, p.1).

There appears to be a consensus that, in the USA, urban crime rates are consistently higher than rural crime rates (see Weisheit, Falcone & Wells, 1999; Ladbrook, 1988; Weisheit & Donnermeyer, 2000). For example, Weisheit and Donnermeyer (2000) found that violent crimes were five to ten times higher in American urban areas compared to rural areas, and property crime was four to five times higher in urban areas compared to rural areas. In addition, data from the FBI (NCVRW, 2013) showed violent crime rates in cities were more than twice as high as in nonmetropolitan (rural) areas. Similarly, robbery rates for cities were more than three times higher than non-metropolitan rural areas. However, crime rates tend not to be homogeneous in this respect; Weisheit and Wells (2001) found that out of 30 counties, nine rural counties were among those with the highest homicide rates. Also, the FBI found that there was little difference in the level of recorded rape cases between cities in metropolitan areas and nonmetropolitan rural areas in the USA (21 per 100,000).

As noted in the last chapter, empirical studies of arson seem to fit the general trends in crime. Thus, Burton et al. (2012) report that arson is now twice as common in urban areas as opposed to the rural areas and there are a number of indications that arson may still be changing from what was previously a rural crime to an urban crime (see, for example, Burton et al., 2012; Wachi et al., 2007). Notably, as urban offenders tend to be younger than rural offenders (Perryman, 2016) and arson offenders tend to be younger offenders in general, one might expect this to be reflected in arson rates. As yet, however, there appears to have been no systematic study of the effects that the urban/rural distinction may have on crime rates in relation to distinctly environmental features. For example, as suggested in the last chapter, travel distances might be different in a rural setting with small, quiet and intimate streets, as

opposed to an urban setting with large intersections and noisy traffic. Urban environments may also present more opportunities for arson attacks nearer to home.

3.5.4. High Crime versus Low Crime Areas

Another way of looking at some of the variables encompassed by Defensible Space Theory and CPTED is to turn the issue on its head, as it were, and look at high versus low crime areas. As noted previously, it is often observed that low crime areas are closely situated alongside high crime areas without knowing exactly why very similar areas have such different crime rates (Winters et al., 2014). However, relevant here may be an old but landmark study by Shaw and McKay (1942); in this, crime rates were found to be highest in the part of a city where houses were deteriorating and close to the industrial areas. Shaw and McKay argue that these areas are cheaper to live in and are, therefore, affordable for those on low income, who have limited opportunities for conventional success. It would be convenient to argue, therefore, that the crime rates were a feature of the characteristics of the people living there. However, Shaw and McKay also found that no matter what racial or ethnic group the individual belonged to, when they moved out of these particular areas, the high crime rates did not move with them. This suggests that the high crime rates were more a feature of the situations in which the residents were placed rather than their personal characteristics. This is also supported by the fact that not every area with cheap affordable homes occupied by low income families are overrun by high crime rates (Fannin & Clinard, 1965; Winters et al., 2014).

Perhaps related to this, Alison, Bennell, Mokros and Ormerod (2002) have proposed that, in the case of arson, the victim is very often not present at the time of the crime. This may mean that the victim has a lesser effect on the arsonist's behaviour than the particular characteristics of the environment in which the crime occurs. Again, this might suggest that

the particular locations of attacks and the features they contain, may be more relevant in arson than in many other crimes. Detailing and understanding these environmental/situational cues and how they trigger unwanted behaviour, (as well as wanted behaviour) might not only aid in our understanding of the choice of crime location for arsonists, and other subgroups of criminals who tend to use their environment in a similar way, but add to our understanding of human spatial activities generally.

3.6. Environmental and Geographical Patterns of Arson and Accidental Fires: An example

As noted previously, to the best of the researcher's knowledge, as yet no study has systematically applied Defensible Space Theory or CPTED specifically to the study of arson. Nevertheless, before moving on, it may be informative to consider the results of one particular study on arson by Bennett et al. (1987) which, although now 30 years old and in need of replication, is perhaps closest to testing Defensible Space theory and CPTED in recent times.

In this study, Bennett et al. (1987) set out to examine the spatial distribution of fires in Springfield, Massachusetts between 1980 and 1984 and to determine the main factors underlying the distribution. The study investigated 440 arson cases and 732 accidental fires and found that both accidental fires, as well as arsons, were clustered in specific neighbourhoods and along certain streets. The majority of arsons ran parallel in two axes throughout Springfield, with only very few exceptions. The two axes where fire-setting activities were clustered could be further split into two sub-regions: a high-crime transitional area and a decaying area of the city (deteriorating buildings, high unemployment, high poverty, and high crime rates). Neither weighting by area (square miles) or by population (number of residents) changed the patterns of fires, which suggests other variables must

function as attraction for fire setting behaviour. Furthermore, the areas where both the accidental and non-accidental fires were most frequent, were overlapping ($r = .40$). Thirteen potential predictor variables were chosen and added in sequence in a regression analysis, based on previous published research. As might be predicted from CPTED and Incivility Theory, a moderately strong correlation was found between arson rate and whether the building was vacated. Correlations of modest strength were also found between higher arson rates and the number of residents below poverty level, the lower the residents' income level, higher number of residents per unit, rented homes as compared to owned homes, and finally the number of high school graduates per unit. Weaker associations were found between arson rate and a number of other variables such as, unemployed residents over 16 years old, density of buildings, older houses, the turnover of the population, and how much rent is charged for the unit occupied. This meant that fewer cases of arson were found in areas with higher home values and rents, where more white people were living, and where the residents had a higher income and educational level (Bennett et al., 1987). Significantly, however, two variables alone accounted for over 70 percent of the reported arson cases. These were housing vacancy (a building where several units were left unoccupied) and tenement type housing (housing structures with five or more units in a single building). Arguably, these latter findings, in particular, accord considerably with the predictions of Defensible Space and CPTED and related findings.

Nevertheless, this study still found a wide variation in the arson across the city of Springfield leaving many influences uncovered and unexplained. Consequently, Bennett et al. (1987) suggested that there may be merit in adopting a smaller scale of analysis and possibly breaking an area down to block level for analysis. Significantly, therefore, the adoption of latter, finer level of analysis was one of the central features of the present thesis.

3.7. Conclusion

To sum up, given there is a lack of research into arson, the ideas and evidence reviewed in this chapter suggest that one potential way forward might be to consider whether arson rates might be predicted by environmental features; particularly those identified by Defensible Space Theory and CPTED, and the related concepts also discussed here. Notably, although some studies mentioned here touch on the subject, to the best of this researcher's knowledge, as yet, there has been no systematic research using these types of environmental concepts with an associated fine grained analysis that has specifically targeted arson. Therefore, in this respect, what follows could be considered to be the first systematic empirical study of its kind.

Part 2

The Empirical Work

Chapter 4

Introduction to the Empirical Work

4.1. Introduction

Before moving on to the empirical studies, it may be beneficial to briefly summarize the main points introduced in the previous chapters that relate to the rationale and associated aims and hypotheses for the empirical research that follows.

As emphasised in Chapter 1, despite the significance of arson as a costly and destructive criminal behaviour, which may be increasing in many parts of the World (Brett, 2004; Cahn, 1998; Davis & Lauber, 1999; Doley, 2003; Epps & Hollin, 2005; Jackson et al., 1987; Pearson, 1994; Tennent et al., 1971), detection and conviction rates tend to be low, particularly in Europe (see, Hall, 2005; Leslie, 2003; Lindholm Mikkelsen et al., 2000; Rasanen, Hakko & Vaisanen, 1995; Tague & Knox, 2013; Walker et al., 2006).

Correspondingly, there appears to be consensus that we know relatively little about arson compared to many other areas of criminal investigation (Hopkins, 2009; Lindholm Mikkelsen et al., 2000; Reno et al., 2000). The work discussed in Chapters 2 and 3 emphasizes that one of the main reasons for this may be that most existing theory and research into arson tends to concentrate on profiling the characteristics of offenders, rather than investigating, at least in any detail, features of the environment that may influence their behaviour. Consequently, very little research exists on how the environment contributes to arson; moreover, what does exist tends to be based on work in the USA (see Dunstan, et al., 2005). Given this, a feature of the present thesis is the detailed empirical investigation of environmental features that may

influence arson rates using a sample and areas from a European country, Denmark. Apart from the fact that Denmark is in Europe, it was also chosen because it is the researcher's own country and she was able to gain the necessary access to relevant archival and case materials. Also important is that much of the conceptual basis for this analysis was based primarily on Defensible Space Theory and CPTED, which have yet to be systematically applied to arson.

However, given that information regarding demographic characteristics of the chosen sample was also available, it was possible to investigate these, not only in their own right, but to assess how well they resemble other findings in the literature, and how they may impact on other variables studied in the empirical work. At the same time, the opportunity was taken to investigate a range of offence related behavioural characteristics related to arson, to address some inconsistencies and gaps in the literature, and again to consider how these relate to demographic and environmental features of arson. Again it can be noted that, even in these regards, this will be one of the few European studies that has addressed these issues, and the first in Denmark.

The issues that could be investigated systematically were necessarily limited by the information available in the data sample; with this in mind, the guiding central issues related to these three areas of investigation (demographic, behavioural and environmental characteristics) are reprised in summary form below.

4.2. Summary of Previously Investigated Variables

The literature reviewed in Chapter 2 suggests that the majority of firesetters are male and with as few as 10-15% female firesetters (Bourget & Bradford, 1989; Fineman, 1980; Hakkanen, Puolakka & Santtila, 2004; Heath, et al., 1985; Santtila, Hakkanen, Alison & Whyte, 2003; Sapp, Hobort et al., 1994; Snyder, 2008; Stewart, 1993; U.S. Department of Justice, 2001; Wachi et al., 2007; Wooden & Berkley, 1984), although several studies suggest

that the proportion of female arsonists is increasing (Burton et al., 2012; Dickens et al., 2014). The majority of arsonists are adolescents (for example, Burton et al., 2012; Edwards & Grace, 2007; Hakkanen et al., 2004; Santtila et al., 2003; Snyder, 1999; Snyder, 2008), or younger (for example, Braig & Whelan, 1995; Cox-Jones, Lubetsky, Fultz and Kolko, 1990), but studies suggest that female arsonists tend to be older than male arsonists (Dickens et al., 2014).

The literature also suggests that firesetters often have a criminal history, are unemployed (Geller, 2008), have been placed outside the home during upbringing (Kazdin & Kolko, 1986; Kolko & Kazdin, 1990) and are poorly educated (Burton et al., 2012; Eidsson, 2005; Santtila et al., 2003; Sapp, Icove et al., 1994) and are White Caucasian (Berkey and Wooden, 1984; Hickie & Roe-Sepowitz, 2010; Santtila et al., 2003; Sapp, Horbert et al., 1994; US Department of Justice, 2011). A number of studies suggest that mental illness is common among arsonists (Burton et al., 2012; Geller, 2008), especially schizophrenia (see, Bradford, 1982; Dejong, Virkkunen & Linnoila: 1992; Harmon, et al., 1985; Hill, Langevin & Paitich, 1982; Koson & Dvoskin, 1982, Leong, 1992; Leong & Silva, 1999; Rix, 1994; Puri, Baxter & Cordess, 1995; Repo & Virkkunen, 1997; Repo, Virkkunen & Rawlings, 1997), personality disorders (Bourget & Bradford, 1989; Dejong et al., 1992; Harmon et al., 1985; Hill et al., 1982; Repo et al.; 1997; Rix, 1994; Stewart, 1993; Taylor et al., 2006) or depression (Burton et al., 2012).

The majority of both single and serial arsonists are young males and both may have a criminal record (Burton et al., 2012; Sapp, Hobert et al., 1994) and serial arsonists tend to more often be in steady employment compared to single arsonists (Sapp, Hobert et al. 1994). The literature suggests that group offenders tend to be younger than solo offenders and that solo offenders are more likely to have a psychiatric history (Wood, 2000). According to Santtila, Fritzon and Tamelander (2004) about half of arson offences are committed under the

influence of alcohol or drugs and one third of the offenders remained at the crime scene, whilst one third left the crime scene (Sapp, Hobort et al., 1994).

With regard to travel distance, arsonists mainly set fire within a range of about 1 to 3 km (Fritzon, 2001; Harling, 1972), which fits with other results suggesting that such crimes are usually committed by young people, and are more likely to be opportunistic and committed in the spur of the moment, fuelled by anger, frustration or boredom etc. (Grant & Kim, 2007). It has also been found that older offenders travelled further than younger offenders (Rhodes and Conly, 1981; Fritzon, 2001; Phillips, 1980), although results appear more contradictory regarding gender where for example Phillips (1980) found that female offenders travelled longer than male offenders, although Fritzon (2001) and Wachi et al. (2007), found the direct opposite. Furthermore, it has been suggested that arsonists are likely to react to elements in their environment (for example, Davies & Dale, 1995; Fritzon; 2001; Rhodes & Conly; 1981; Sapp, Hobert et al., 1994; Trotta, 2012) and a variety of obstacles in the environment may, therefore, influence the distances travelled by the offenders (Trotta, 2012). As such, Defensible Space Theory and CPTED Theory might provide a possible conceptual base for making predictions about environmental features. For example, territorial functioning and territorial markers (Abdullah et al., 2012; Bell et al., 1996; Bennett and Wright, 1984; Brown & Altman, 1983; Crowe, 2000; Donnelly, 2010; Newman, 1972; Newman, 1996), a general lack of maintenance of a neighbourhood (Crowe, 2000; Wilson and Kelling, 1982), the presence of graffiti (Wilson and Kelling, 1982), a lack of surveillance, and distance from the nearest police station (Crowe, 2000; Newman, 1972; 1996), high rise buildings, places of entertainment, and public buildings (Bennett et al., 1987; Newman, 1972, 1996). Furthermore, population density has been associated with crime (Agnew, 1999; Coleman, 1990; Wirth, 1938), as has urban areas (Ladbrook, 1988; NCVRW, 2013; Weisheit, Falcone & Wells, 1999). For example, One might predict, therefore, that

arson, may be more prevalent in urban areas, where, due to higher population and building density, there is more opportunity to offend. Together with possible obstacles to travel (such as busier streets), the increase in opportunities might also lead to shorter travel distances in urban areas.

4.3. Research Aims

In light of the literature and issues summarised above, given that most of the work on arson, and particularly on environmental factors in crime generally, has been conducted in the USA, the overarching theme of the current thesis was to describe and evaluate some of the main demographic, biographical, behavioural and environmental factors associated with arson in a European sample (Denmark). Within this overarching theme, four main aims emerged:

1. To describe and evaluate the demographic and biographical characteristics of a European sample of arsonists from rural and urban areas. This includes factors such as, age, gender, nationality, ethnic background, psychiatric history, criminal record, and educational and work history; and additionally, to assess their relationships with solo and group offending, serial and individual offending, and offending in rural and urban environments.

2. To describe and examine the relationships between the offence related behavioural characteristics of arsonists, within the same sample, such as travel distances, use of accelerants, use of alcohol, crime scene behaviours, and, where appropriate, previous history between victim and offender, and to assess their relationships with the demographic and biographical variables investigated under the first aim.

3. To examine the influence of a range of architectural and structural features of the environment in relation to arson rates, to establish the relative influence of, and possible interactions between, a variety of related variables, particularly those derived from Defensible Space theory, CPTED (Crime Prevention Through Environmental Design) and

Incivility Theory; and from this, to present a possible framework for understanding which features, and types of neighbourhoods, attract firesetting behaviour and why.

4. Where possible, to assess the relative effectiveness of the above variables in predicting arson rates.

4.4. Hypotheses

Although much of the empirical work was exploratory, nevertheless, on the basis of the literature, and the considerations above, it was possible to generate a number of hypotheses in relation to the defined aims. The hypotheses for the individual studies are presented along with the studies in their corresponding chapters; some illustrative examples can be grouped as follows. Again it should be noted that these were restricted by the information available in the data sample.

4.4.1. General Demographic and Biographical Characteristics

1. In terms of demographic and biographical characteristics, the majority of offenders will be young adolescent white males who live with their parents, are unemployed, have a history of disruptive behaviour, including previous criminal convictions, have adjustment and alcohol issues, and have mental health problems (psychiatric history).

2. Compared to female offenders, male offenders will tend to be younger, be more likely to have alcohol abuse issues, and be more likely to be unemployed.

4.4.2. Solo versus Group and Single versus Serial Offenders

3. Compared to solo offenders, arsonists operating as a group will be younger, and have a history of disruptive behaviour alongside adjustment issues. Solo offenders will be

more likely to have a psychiatric history and will not have been enrolled in school at the time of their offences.

4. The majority of arsonists will be single (i.e. one-time) offenders, though, overall, serial offenders would tend to show the same demographic characteristics as their single offence counterparts; however, serial offenders would be more likely to start setting fires at a later age and be in stable employment.

4.4.3. Offence Related Behavioural Characteristics

5. In terms of offence related behavioural characteristics, the majority of the offenders will use an accelerant, bring fire lighting materials with them and offend under the influence of drugs or alcohol. However, these behaviours will be more pronounced in solo offenders, and those who have a psychiatric diagnosis. Additionally, solo offenders, and those with a psychiatric diagnosis, will more likely to know their victims.

6. The majority of offenders will not travel far and overall; travel distances will be shorter in urban areas, and where there are environmental obstacles. Travel distances will be mediated by age and gender; hence, older offenders will tend to travel further. However, the hypothesis for gender is two-tailed, as what little literature there is on the subject is contradictory.

4.4.4. Environmental Characteristics

7. In terms of environmental characteristics, neighbourhoods with more Defensible Space/CPTED characteristics (territorial markers, surveillance from and over property) will have lower rates of arson than neighbourhoods low on CPTED/Defensible Space characteristics. Relatedly, arson rates will tend to be higher in busy commercial areas and areas with vacant houses.

8. In accordance with incivility theory, arson will be higher in areas where properties are poorly maintained, including having broken windows, littered pathways and streets, and graffiti etc.

9. Arson rates will be higher in areas of high population and building density, and correspondingly, there will be more arson offences in urban areas as opposed to rural areas.

4.5. Organisation of the Studies

With the aims and hypotheses identified above in mind, the following studies were conducted.

4.5.1. Studies 1 and 2 - Demographic and Biographical Characteristics of Arsonists

The main purpose of Studies 1 and 2 was to describe the demographic and biographical characteristics of the sample in light of the existing literature, and to test the hypotheses as identified. A variety of relevant demographic and biographical characteristics were explored, including, most particularly, age and gender, but also, serial (multiple) versus single (one-time) offending, criminal record, psychiatric history, employment status, nationality and ethnicity.

4.5.2. Studies 3 and 4 – Offence Related Behavioural Characteristics of Arsonists

Studies 3 and 4 examined a number of offence related behavioural characteristics of arsonists; these included variables such as offence targets (residential, business etc.), solo versus group offending, travel distances, the use of accelerants, use of alcohol, firing multiple sites and items, and how these variables might be influenced by previous history between victim and offender, including previous threats and/or violence towards the victim.

Analysis was also conducted to examine possible relationships between these variables and the demographic and biographical characteristics identified earlier.

4.5.3. Study 5 – Predicting Individual Arson Rates from the Offence Related and Demographic and Biographical Variables: Serial Arson Revisited.

The aim of Study 5 was to estimate which variables from Studies 1-4 are most likely to affect individual arson offending rates and, thereby, identify those individuals most likely to offend again. However, as actual recidivism was not measured in the present studies, an indirect or proxy measure was needed. In the present study, the measure chosen was *previous convictions for arson*; in effect then, this study revisits the variable of single (one-time) versus serial arson offending, which is potentially one of the most important criteria in the study of arson for which it would be useful to identify risk factors.

4.5.4. Study 6 – Further Environmental Aspects of Arson

Study 6 concerned a further detailed investigation into the architectural and structural features of the environment in relation to arson rates in the sample. The aim was to establish the relative influence on arson rates of a number of variables that could be related to this outcome, including those derived from Defensible Space theory and CPTED, such as high rise buildings, closeness to population clusters, fences/hedges, and surveillance from and over properties. Also included were related variables derived from Incivility Theory, such as the presence of broken windows, littered pathways and streets, and graffiti.

Chapter 5

Data Collection and Methodological Considerations

5.1. Introduction

The aim of this Chapter is to describe how the data were collected for the empirical studies and some important methodological considerations that guided the analysis and interpretation of these results.

5.2. Data Sources and Collection

The primary data set used for the empirical work in this thesis consisted of records of all convicted arsonists (i.e. solved cases) in two selected police districts in Denmark during the period of 2002 to 2010. The data concerned offenders charged with §180 and §181 penal code violations only. When arson is directed towards unfamiliar property, or if the offender's intention is to commit fraud, it is classified as a §181 violation. Penal code §180 includes the more serious offences of firesetting, where the offender realises that the arson puts other people in danger. This resulted in a sample of 746 arson cases involving 540 offenders. Within the time constraints, the particular time period (eight years) was selected as adequate to accumulate a sufficient amount of data to carry out a reasonably valid and reliable investigation.

The two police districts were the Middle and Western Jutland district and Copenhagen Western district. These two districts were chosen as they could be considered to be representative of Denmark as a whole in relation to many of the main variables investigated in this thesis (population density, building density, crime rates, etc.). The Middle and Western Jutland police district is geographically the largest police district in Denmark covering

9.61km² and is recognised as a mainly a rural area according to Weekes' definition recognised by Unicef (2017) (see Chapter 3). The district includes 11 councils, and in late 2010 had 582,377 inhabitants; the population density within this district is in generally low and varies from zero to 100 inhabitants per km². The Copenhagen Western district is a contrasting district which covers the areas west and northwest of the capital; and is recognised as an urban area using the Unicef definition; it includes 11 councils and has 380,000 inhabitants from 175,000 households spread over an area of 275 km².

The data came from two sources, extracted solely by the researcher over the period of three years, and constituted three related data sets: the total set of 540 offenders and the 746 cases committed by these offenders, and a smaller subset of the total sample containing 355 offenders from which more information was available. Because of their sensitivity, the data sets were encrypted and kept in a secure location at all times and only the researcher had access to the information. The first source was the records at the NEC (National Efterforsknings Center/ National Investigative Centre) based in Copenhagen. The NEC is a subdivision of the Danish police, which is responsible for crime prevention and international cooperation, and provides support for police districts especially in regard to organised crime, both nationally and abroad. The NEC is, therefore, the coordinator for any research based on Danish data. The data from the NEC included personal ID number, age, gender and ethnicity, as well as time and date of the crime and geographical location of the crime and home location of the offender.

However, for more details it was necessary to contact the individual police stations that had dealt with the crimes, i.e. police stations within the borders of a particular police district in which a crime had occurred. Accordingly, the researcher sourced the hard copy records of every arson case in every police station in the two districts (10 stations in the rural area, and four in the urban area) that was identified as having such records. This additional

data included more background demographic information, such as living circumstances, whether the offender had psychiatric problems, or had engaged in substance misuse, etc. To reiterate, the data collected from the NEC was extracted from computer records, whereas the data from the individual police stations was extracted from hard copy records, which had to remain at the police station and it was therefore not possible to test interrater reliability. Also, it was not possible to match all cases and offenders to the data extracted at the individual police station by personal ID number, there were only 355 offenders for whom full information was available (i.e. they could be matched from the two sources); full records for the remaining 185 could not be sourced. In reporting the present studies, therefore, it will be stated whether the information was based on the 355 offenders for whom full information was available, or based on the larger sample of 540 offenders for which more limited information was available.

5.3. Advantages and Limitations of Archival Data

It should be noted there are a several advantages associated with using the kinds of archival data employed in this thesis. For example, Canter and Alison (2003) have pointed out that unobtrusive measures derived from records of police investigations can provide a different perspective on crime and provide a rich source of information often inaccessible through interviews and questionnaires; moreover, models and inferences drawn from these kinds of archival data may be more directly relevant to law enforcement. Also, although in the first instance, the data were not collected for the purposes of scientific research, it can potentially provide a relatively objective account of the events, not biased by experimenter effects, and not reliant solely on details as remembered or stated by the arsonist. In this respect, they may also reduce the influence of offender dishonesty which is a particular problem with questionnaires and self-reports.

However, there are also limitations to this type of data. For example, there is no control over how the data were collected originally at the individual police stations; this not only limits the amount of relevant and reliable information available, but allows variation in the amount of, and kinds of, information gathered from different sources (for example, individual police stations may differ in the information they are able to provide). Another issue associated with working with this type of data is the requirement for the case to be solved to allow investigation of offender characteristics. One consequence is that cases are often underreported and do not reflect the actual number of incidents that have taken place (Cantor & Cohen, 1980; Riedel, 1990; Rokaw, Mercy, & Smith, 1990; Tennenbaum, 1993). Underreporting is a general feature of archival data retrieved from other sources such as prisons, hospital records, and schools which are commonly used for research purposes. However, for underreporting to have seriously and systematically affected this study's outcomes, one would have to propose that the cases were differentially reported according to the age, gender etc. of the individuals involved in the cases. Whilst this is possible, there seems to be no obvious reason for expecting this to occur.

Given these limitations, any results obtained should be treated with due caution, and be considered provisional until replicated. Nevertheless, it can be argued that, on the whole, and particularly within this context, the strengths of the archival approach outweigh its disadvantages, and official police records remain the most useful tool for investigating variables relevant to understanding offender characteristics and other influences on their behaviour Canter and Alison (2003).

5.4. Approach to Statistical Analysis

Given the aims of the thesis and the range of variables and hypotheses involved, a variety of inferential statistical procedures were considered. For clarity, and to reduce repetition, it may

be useful here to provide an overview regarding the general approach to their choice and application.

5.4.1. Basic Inferential Tests

Three main levels of analysis were used. Where appropriate, both to describe the data in general, and target individual hypotheses and more detailed trends, standard procedures for frequency analysis such as the Binomial Test, Phi Coefficient estimates, and Chi-square tests, were applied.

The next level involved basic multivariate analysis with consideration of interactions where the data allowed. Although there are procedures for consideration of interactions in more global multivariate procedures, such as multiple regression analysis, statistically, the terms have to be factored in individually and can add greatly to the complexity of both computation and interpretation (Aiken & West, 1991). In the present studies, there seemed little point in arbitrarily targeting all possible interactions between the large numbers of variables under investigation, when there were no prior reasons for doing so (see again, Aiken & West, 1991). Instead, possible key interactions, such as those between gender and other variables when investigating age differences (because males and females might be expected to show different age profiles), were targeted more specifically through individual ANOVA procedures.

Although some attempts have been made to develop non-parametric tests that will deal adequately with nested data and interactions (see, for example, Leys and Schumann, 2010), there is, as yet, no widely accepted and available non-parametric method for doing this. This was potentially problematic as, in the present studies, the age distributions in particular, appeared to violate the standard assumption of normality associated with parametric tests. Nevertheless, a number of researchers have pointed out that parametric

ANOVA procedures are relatively robust in the face of violations of both the normality and homogeneity of variance assumptions with fixed levels of the independent variable, and especially with large sample sizes, as in most cases here. It should be noted that there may still be issues if the sample sizes are very unequal (see, for example, Howell, 1992; Kirk, 1968; Schmider, Ziegler, Danay, Beyer, & Bühner, 2010; Shavelson, 1996). One possible way forward, might be to first analyse the data using standard parametric ANOVA procedures and, if any effects were significant, to follow these up with post hoc non-parametric procedures (such as Mann-Whitney tests) as a check. However, a number of studies have indicated that there may be little to be gained by this, given that, with reasonably large sample sizes, standard parametric procedures for independent groups, such as the *t* test and point biserial correlation, remain remarkably robust to violations of the standard assumptions and may sometimes out-perform their non-parametric equivalents in this respect (see, for example, Fowler, 1987; Guiard, & Rasch, 2004; Heeren & D'Agostino, 2006; Rasch & Guiard, 2004; Sawilowsky, & Clifford, 1992). Indeed, Rasch and Guiard (2004) conclude, “Generally the results are such that in most practical cases the parametric approach for inferences about means is so robust that it can be recommended in nearly all applications (p.175)”. This is particularly the case with the Welch test, which appears to be very robust not only with regard to non-normality and heterogeneity of variance, but also to unequal sample sizes (Delacre, Lakens, & Leys, 2017; Ruxton, 2006). Given this, throughout the empirical work in this thesis, where the data were, in principle, amenable to parametric analysis (such as by ANOVA, *t* tests and point biserial correlation), standard parametric procedures were applied. However, any significant ANOVA effects were checked using Welch tests. In the case of the latter, unless otherwise reported, results were comparable. Welch tests were also used to detail significant ANOVA interaction effects.

5.4.2. Multiple Regression

The final level of investigation in this thesis involved applying procedures that would best capture the relative importance of the many variables under consideration in predicting relevant parameters. As Goodwill, Alison and Beech (2009) have emphasised, in the area of offender profiling generally, there are two main ways in which this may be achieved. One way is to attempt to cluster a range of variables into themes or typologies on the basis of their statistical relationships with each other (through, for example, cluster analysis, principle components analysis, factor analysis, or Smallest Space Analysis) and then use these to predict offending. An alternative approach, is to side step the thematic or ‘clustering’ phase, and simply apply a standard multivariate regression approach to the variables under consideration (see, for example, Edwards & Grace, 2014; Goodwill et al., 2009).

Significantly, using a sample of 85 stranger rapists, Goodwill et al. (2009) compared the three established typological/thematic models with a simple multivariate logistic regression approach to assess their ability to predict an offender’s previous convictions from crime scene information. Their conclusion was that “predictive analyses based on a multivariate approach using a mixture of crime scene behaviours, as opposed to the grouping of behaviours into themes or types as in the three models, far exceeded the predictive ability of the three models” (p.507). Consequently, simple correlational and multiple regression approaches were adopted in the present thesis to assess relationships between, and predictions from, the variables as a whole.

Given the nature of the data in the present thesis, the most appropriate multiple regression approach was that used by Goodwill et al. (2009); that is, binary logistic regression (BLR), with the dependent variable coded dichotomously. Consequently, this was the primary regression tool used. Furthermore, it can be noted that when using logistic regression, the standard measure of effect size for a binary independent variable is the odds

ratio (OR) ; technically known as the Exponentiation of Beta or $\text{Exp}(B)$. When beta signs are positive the interpretation of the odds ratio is straightforward; it tells you the difference in odds between the two categories in the classification. So for example, an OR of 4.30 would tell us that those in category 1 of the independent are over four times as likely to appear in category 1 of the dependent variable, as those in category 0 of the independent variable. However, when beta signs are negative the values of $\text{Exp}(B)$ fall below 1 with a minimum possible value of 0. This makes comparisons of the ORs for positive and negative beta signs difficult to conduct as they are not on a simple linear scale. In such cases, therefore, when citing comparative ORs in the text, the convention is to convert to the $\text{Exp}(B)$ values to those they would have been had the sign been positive, by using the reciprocal value; i.e. $1/\text{Exp}(B)$. This convention was, therefore, followed in this thesis.

In addition to the standard logistic regression table, and as also recommended by Goodwill et al. (2009), and used by Edwards and Grace (2014) and Rice and Harris (1995), ROC (Receiver Operating Characteristic) analyses were also conducted. ROC analysis enables the calculation of an area under the curve (AUC) statistic to assess both the hit probability (pH) and the false alarm probability (pFA) simultaneously. For example, if we use previous/ no previous convictions for arson as the outcome measure, then the hit probability (pH), or sensitivity, assesses the probability that the regression model has correctly predicted the presence of a previous record of arson, whereas the false alarm probability (pFA), or 1-specificity, assesses the probability that the model has incorrectly predicted the presence of a previous record of arson. The AUC analysis then plots the relationship between p(H) and p(FA) producing an ROC curve, and the area under the curve (AUC) is used as a measure of the diagnostic accuracy of the prediction of previous record of arson. Hosmer and Lemeshow (2005) provide the following guide for classifying the accuracy using AUC statistics which is applied here: .90-1.00 = Outstanding, >.80- <.90 =

Excellent, >.70- .80 = Acceptable/Satisfactory, >.60-.70 = poor, >.50-.60 = fail. The AUC is a useful measure as it provides a general measure of the predictive value of the regression model that can be compared directly with other models (Edwards & Grace, 2014; Goodwill et al., 2009; Rice & Harris, 1995). As such by calculating AUC statistics it was possible to compare the relative efficacy of variables as predictors in each case; each can be used as a kind of effect size (Goodwill et al., 2009).

In further support of the above approach, is the use of a series of Binary Logistic Regressions (BLR) and ROC analyses is now being considered 'common practice' in criminal profiling literature (see Markson, Woodhams & Bond, 2010, p.98; and for further examples, Bennell, 2005; Bennell & Canter, 2002; Bennell & Jones, 2005; Fujita et al., 2012; Tonkin et al., 2008; Woodhams & Toye, 2007).

One of the most important advantages of logistic regression over standard multiple linear regression is that the former has far fewer assumptions. Consequently, a standard forced entry procedure, that included all the main variables, was used in the following analyses (Field, 2009; Studenmund & Cassidy, 1987). The fewer assumptions are important, as unlike ANOVA and *t*, multiple linear regression is not robust to violations of most of its many assumptions (Field, 2009; Osborne, & Waters, 2002; Tabachnik & Fidell, 2001). However, sample size remains an issue with BLR, so in the following analyses, sample size always exceeded the fairly conservative rule of thumb for BLR of 10 observations per independent variable (Vittinghoff, & McCulloch, 2007). Also, the rule of independence of observations was followed in all cases. The assumption of linearity of the logit was not tested directly. However, this would not have been an issue in most of the analyses as the majority of the variables were binary; moreover, problems with the linearity of the logit can usually be identified by poor and non-significant pseudo R^2 statistics (Nagelkerke R^2), and indicators of model fit such as the AUC, which were calculated for all regressions (NRCM, 2011).

Another issue, concerns the method of entry used in the analysis; i.e. whether to enter all of the variables considered relevant ('forced entry'), and base the final model on this, or use a progressive stepwise method that results in a model containing only those independent variables that contribute significantly to the model fit. For many years there has been a growing, widely held, view amongst statisticians that stepwise regression approaches are invalid and inappropriate within the framework of the scientific method. Among the many problems are that stepwise procedures capitalise on chance factors in the data, greatly exacerbate Type 1 errors, and very often produce unreliable models (see, for example, Harrel, 2015; Henderson & Velleman, 1981; Judd & McClelland, 2008; Mundry & Nunn, 2009; Knapp & Sawilowsky, 2001; Studenmund & Cassidy, 1987; Tabachnick & Fidell, 2001; Thompson, 1989, 2001; Whittingham et al., 2006; Wittink, 1988). Consequently, in the present thesis, as recommended by authorities such as Studenmund and Cassidy (1987), and Mundry and Nunn (2009), a standard, full model, forced entry procedure was adopted for all multiple regression analyses.

A final issue regarding multiple regression concerns validation of the model. One approach that has been advocated by some is data splitting; that is, splitting the data into two independent samples, and attempting to apply the regression model from one sample to another. However, this approach has been subject to a number of criticisms, major issues being the inevitable loss of statistical power, the limitations on statistical analysis imposed by decreasing the sample size, and the questionable rationale behind attempting to validate a model using a sample drawn from essentially the same population (Dallal, 2012). In the present studies, the main source of information was a sample of 355; though relatively large by some standards, given the number of variables under consideration, there was, nevertheless, little leeway to reduce it further and still be able to make meaningful statistical inferences. A data splitting procedure was not, therefore, adopted in the present studies.

Rather it was assumed, that any results should be treated with appropriate caution until replicated, preferably by different researchers using an entirely different sample (see Thayer, 2002).

5.4.3. Treatment of Multiple Comparisons

A final consideration in the present thesis was the interpretation of statistical probability in large numbers of comparisons. When more than one statistical test is performed when analysing data, some have argued that a more stringent criterion be used for ‘statistical significance’ than the conventional $p < 0.05$. A standard way of achieving this has been through the Bonferroni correction, which involves dividing the alpha level for each comparison by the number of comparisons i.e. α/n . An alternative, slightly less conservative option, is the Holm-Bonferroni sequential procedure (Holm, 1979). However, more recently, there has been a trend away from such procedures. For instance, Nakagawa (2004) has argued that, “Adjusting statistical significance for the number of tests that have been performed on study data—the Bonferroni method—creates more problems than it solves” (p.1045), and Perneger (1998) concludes that, “Bonferroni adjustments are, at best, unnecessary and, at worst, deleterious to sound statistical inference” (p.1236). Reported problems include the arbitrariness of the procedure over multiple tests (at the different times, in different samples by different researchers etc.). However, perhaps the main weakness is that, because the interpretation of a finding depends on the number of other tests performed, the likelihood of type II errors is also increased, such that, as the number of tests increases, truly important differences can easily become insignificant. Given this, preferred options are simply describing what tests of significance have been performed and why, and stressing the importance of caution in interpretation and the need for replication (Nakagawa, 2004; Perneger, 1998). Accordingly, the latter approach was adopted in this thesis.

5.5. Ethical Considerations

The overall study was first approved by the Liverpool University Ethics Committee.

To receive clearance for data collection, the researcher then presented an official letter to the Commissioner of Police of Rigspolitiet in Denmark, detailing the aims of the study, the type of data required, and the procedures for dealing with confidentiality. Formal permission was subsequently granted. To ensure confidentiality, all data were anonymised by assigning a number to each offender and removing any reference to the name.

Chapter 6

Study 1 - Demographic and Biographical Characteristics of Arsonists: Gender, Age, Locality and Single versus Serial Offending

6.1. Introduction

To recap, the first main aim of the present thesis was to describe and evaluate the demographic and biographical characteristics of a European sample of arsonists from rural and urban areas. Therefore, the purpose of the first two studies, was to describe the demographic and biographical characteristics of a sample of Danish arsonists in relation to age, gender, location (rural or urban), single versus serial offending, psychiatric history, criminal history, education, domestic and employment status, nationality, and ethnicity. To aid clarity in the presentation of the large volume of results they are presented in two parts, labelled as Study 1 and Study 2, over the following two chapters.

In this Chapter (Study 1), the broad influences of gender, age, locality (urban/rural) and nature of offending (single vs serial offending) are considered. The reasons for choosing these particular variables for initial analyses were twofold. Firstly, gender and age are generally considered to be the most important, and certainly the most researched, demographic variables in the field (indeed, in most areas of criminal psychology). Consequently, these two variables were given priority as a way of detailing the other variables i.e. the initial primary concern in investigating demographic and biographical variables was their relationship with gender and age. Secondly, gender, age, locality and single versus serial offending, were all variables that were recorded in every arson case

available ($N = 540$); i.e. relative to the other variables, the maximum number of cases was available. As evident from the previous chapter, due to differences in the amount of information available for different cases from different sources, the main sample of 540 offenders had to be reduced to a smaller subset of 355 offenders to study certain variables. However, by investigating, and comparing results relating to the above variables in both the main sample and the smaller subset, it was possible to check, at least to some degree, the general representativeness of the smaller sample making it an important feature of the analyses reported in this chapter.

6.2. Hypotheses

Although much of the following analysis was descriptive and exploratory, as noted in Chapter 5, it was possible to derive some key hypotheses from the relevant literature regarding the chosen variables. These were as follows.

1. In terms of demographic and biographical characteristics, the majority of offenders will be young adolescent males.

2. The majority of arsonists will be single rather than serial offenders. Overall, serial offenders would tend to show the same demographic characteristics as their single offence counterparts. However, serial offenders would be more likely to start setting fires at a later age and be in stable employment.

3. There will be more offenders in an urban area than in a rural area, and offenders will be younger in the urban area.

6.3. Method

6.3.1. Data Samples

The data sources and their collection are described in Chapter 5.

As the main aim here, and in the next chapters, was to explore the demographic and biographical characteristics of the sample, it would obviously be advantageous to use the largest sample size possible to explore each relevant variable. As noted, potentially the largest sample was the number of cases ($n = 746$); however, due to the violation of the statistical assumption of independence of cases, statistical investigation of the larger sample of 746 cases was severely limited. Consequently, in terms of conducting comparisons using inferential statistics, it was decided to concentrate on the 540 and 355 offender data sets. However, the issue then arises as to whether the smaller subset of offenders (for whom more information was available) can be deemed representative of the larger population of offenders. Consequently, in this chapter, the opportunity was taken to compare the larger sample with the smaller subset (For a summary of the codings of variables used in this chapter see Appendix 1).

6.4. Results

To reiterate, the main data sets for the present investigations were the total set of 540 offenders and 746 offences/cases committed by these offenders, and then a smaller subset of 355 offenders for whom more detailed demographic information was available.

6.4.1. Preliminary Global Analysis for the Age Data

6.4.1.1. Defining Age: Defining arson in terms of age requires a metric that can be applied to individual offenders. To arrive at a single and comparable age estimate, for each offender, as distinct from each offence, the convention in the literature appears to have been to use the ‘mean age’ of each offender. However, as Wright, Vander Ven and Fesmire (2016) have pointed out, definitions of ‘mean age’ for offenders tend to vary widely from study to study. Hence many studies mention that they have applied ‘mean age’ but do not qualify how it was

derived, while other researchers appear to be entering the age of offender variously as the age at the time of the research interview, time of arrest, incident or conviction, or, at the other extreme, at the beginning of the crime series or at first known offence. Moreover, researchers rarely use any rationale or justification for doing so. However, defining age in these different ways, as well as being arbitrary, is problematic, as the different methods may give very different and potentially contradictory results. Suppose, for example we have two offenders, one with an age range for offences from 20 to 30, and the other with a range from 22 to 28. Depending on which end of the range we use, one offender would variously be classed as older or as younger than the other. However, of all the definitions, arguably, age of first offence seems conceptually to be the most logical for a number of reasons.

For instance, the main problem with any ‘time sampled’ definition of age, such as age at the time of arrest, or at the time of the most recent offence, is that it tells us nothing about where an offender is in terms of his or her criminal career. For example, if we want to investigate whether there are predictive relationships between age, offending and other variables, it seems counterintuitive to label someone last arrested at the age of 70, but who had started offending at the age of 10, as more representative of a class of ‘older offenders’, than someone who started offending at 67 and was arrested at the age of 68 (and might potentially be intending to offend until 90). On the other hand, age of first offence is finite and potentially has considerably more practical significance. If we know, for example, that more offenders start their criminal careers earlier in urban areas, it suggests that young people may be more vulnerable in those areas and we can investigate why. Conversely, if we know that in some areas, offenders appear to embark on their criminal careers very late in life, we can again usefully investigate what variables might be responsible for this. In the present study, therefore, in line with a number of other studies on offending (see, for example,

Edwards & Grace, 2014; Wright et al., 2016), the age of the offender's first arson offence was used as the measure of 'age'.

As demonstrated shortly, it can be noted that, in line with predictions, the large majority of arsonists tend to be single (one-time) offenders. One implication is that, for most offenders, their age at their first offence, and that at their most recent offence, or at arrest, will be more or less the same. And, indeed, this was the case in Edwards and Grace's (2014) study of 1250 arsonists from New Zealand, where the means for first offence and age at the criterion year were more or less identical. This potentially enables us to make meaningful comparisons between different samples, at least in a very broad sense, despite different definitions of offender age.

6.4.1.2. Global ANOVA: Before breaking down the data into sections, a preliminary global analysis was conducted on the age data. The mean age data (i.e. age at first offence) were analysed using two 2 x 2 x 2 between subjects ANOVAs (Rural/Urban x Serial/Single x Male/Female), one for the main sample of 540 and one for the smaller subset of 355. The relevant descriptive statistics are shown in Tables 6.1 to 6.6, and will be detailed in the following sections. The ANOVA for the main sample (540) found only one significant result, females were significantly older than males overall at the time of their first offence, $F(1,532) = 13.84, p < .001, \eta^2_p = .025$. None of the other main effects or interactions approached significance ($F < 1$). Similarly, in the smaller subset (355), there was only one significant result, females were again significantly older than males overall, $F(1,347) = 14.34, p < .001, \eta^2_p = .024$, and none of the other main effects or interactions approached significance ($F < 1$).

6.4.2. Gender and Age at First Offence

The overall descriptive statistics regarding gender and age at first offence for the three samples (746 cases; 540 and 355 offenders) are shown in Table 6.1. (*Please note, in all the following Tables, Median, mode mean and range refer to age of first offence*).

In the sample of 746 cases, 88% were committed by male offenders and 12% by female offenders. In relation to the main sample of 540 offenders, 87% were males, and 13% were females; and in the subset of 355 offenders, 85% were male and 15% were female.

Obviously statistical comparisons between subsets, using Chi-square tests, for example, were not possible because the cases were not independent; however, the male/female split was clearly very similar, and in the two samples of 540 and 355 offenders, the differences between males and females were both significant in the same direction, i.e. more males than females (Binomial tests, $p < .0001$). Importantly, as hypothesised, these results broadly reflect the same gender ratios found in the wider literature on arson; i.e. only 10 to 15% of the offenders were female.

Table 6.1: Descriptive statistics by Gender for the three samples (Median, mode mean and range refer to age of first offence).

		N	Median	Mode	Mean (SD)	Percentage	Range
Offences (N = 746)	Total	746	18	14	22.43 (12.71)	100	61 (6 - 67)
	Male	656	17	14	21.54 (11.79)	88	58 (6 - 64)
	Female	90	22	13	28.97 (16.72)	12	59 (8 - 67)
Offenders (N = 540)	Total	540	16	14	21.80 (12.93)	100	58 (6 - 68)
	Male	470	16	14	20.65 (11.68)	87	59 (8 - 67)
	Female	70	23	14	29.47 (17.62)	13	61 (6 - 67)
Offenders (n = 355)	Total	355	15	14	21.27 (13.08)	100	61 (6 - 67)
	Male	301	15	14	19.93 (11.62)	85	57 (6 - 63)
	Female	54	21	13	28.78 (17.67)	15	59 (8 - 67)

As predicted, overall, most offenders were young at the age of their first offence; the means were around 22 years, and the modes even younger at 18 or less. Also as predicted, the

breakdown in Table 6.1 demonstrates that the overall mean age of first offence for the male offenders was seven to nine years younger than the female offenders in all three data sets. With regard to the two main data sets ($N = 540$ and $n = 355$), this is reflected in the overall significant main effect for age shown in the global ANOVAs.

The median was also consistently higher for females throughout the three data sets. However, interestingly, the mode was similar for both males and females in the three data sets, i.e. 13 or 14 years old. This discrepancy with the other measures of central tendency, would indicate that age was distributed differently for males and females.

To explore this further, histograms were produced for the two data sets of offenders ($N = 540$, $n = 355$) (see Appendix 2). The overall distributions for age for the two samples look very similar (see figures 6.1a and 6.1b in Appendix 2); i.e. both samples tend to be positively skewed and the majority of the offenders are 18 years or younger. The distributions for males in the two samples (see figures 6.1e and 6.1c in Appendix 2) are also very similar to each other. In contrast, the distributions for female arsonists (figures 6.1d and 6.1f in Appendix 2), in both samples, show a tendency towards a bimodality. As with their male counterparts, the female distributions show a group of arsonists in the middle and late teenage years, but, unlike the males, there is a second, smaller group of female arsonists in their late 30s and early 40s. In sum, the female group were not only, on average, older at the time of their first offence, but they were also a more diverse group consisting of two main groups in relation to age.

6.4.3. Gender and Age of Offenders in Rural and Urban Settings

Offenders were coded as Urban and Rural according to the areas in which their records were kept in individual police stations; i.e. the Urban/Rural district (see Chapter 5) in which the records were kept, not where the offender resided at the time of the crime. In the large

majority of cases, given the relatively small travel distances concerned, historically, offenders tended to commit offences in the same district as their main place of residence. There were, however, a minority of around 8% who travelled more than 50 km (and sometimes over 100 km) to offend, sometimes from another district. Interestingly, according to the police officers in charge of the records, a number of these offenders had moved away from their official place of residence, for example, to an institution, but had travelled back to their home district to offend. Given these considerations, the district in which records were held seemed to be most sensible option for coding the Urban/Rural variable.

The results for age and gender in the urban and rural settings can be seen in Table 6.2.

Table 6.2: Descriptive statistics by Gender and Urban and Rural Settings.

			<i>N</i>	Med	Mode	Mean (<i>SD</i>)	Percentage	Range
Offenders (<i>N</i> = 540)	Rural	Total	257	17	14	22.34 (12.43)	100	57 (6 – 63)
		Male	227	17	14	21.77 (11.95)	88	57 (6 – 63)
		Female	30	17	14	26.63 (15.15)	12	46 (10 – 56)
	Urban	Total	283	16	14	21.30 (13.38)	100	61 (6 – 67)
		Male	243	15	14	19.61 (11.35)	86	58 (6 – 64)
		Female	40	26	12*	31.60 (19.18)	14	59 (8 – 67)
Offenders (<i>n</i> = 355)	Rural	Total	214	18	13*	22.82 (12.93)	100	56 (7 – 63)
		Male	185	17	13	22.10 (12.53)	86	56 (7 – 63)
		Female	29	22	14*	27.45 (14.69)	14	44 (12 – 56)
	Urban	Total	142	14	14	18.94 (12.96)	100	61 (6 – 67)
		Male	114	14	14	16.42 (9.08)	80	57 (6 – 63)
		Female	28	20	13	29.21 (19.90)	20	59 (8 – 67)

*Multiple modes exist. Smallest mode is shown.

In relation to the full sample of 540 offenders, 48% were rural offenders and 52% were urban offenders. However, in the smaller subset of 355 offenders, 60% were rural and 40% were urban offenders. In both samples the results were significant (Binomial tests, $p < .005$), but in opposite directions; in the larger sample there were more urban offenders than

rural offenders, but vice versa for the smaller subset. Possible reasons for this discrepancy will be discussed in the concluding section of this chapter.

The full sample of 540 offenders had a large majority of males; i.e. males accounted for 88% of offenders in rural areas and 86% in urban areas. Similar significant trends were shown in the smaller sample of 355 offenders; i.e. there were 86% and 80% male offenders in the rural and urban areas, respectively (Binomial tests showed significantly more males than females in all cases, $p < .0001$). These findings again reflect the same male dominant gender ratio found in wider literature on arson. There were also no significant differences in these ratios between the rural and urban samples; $\Phi(540) = -.037, p = .395$; and $\Phi(355) = -.086, p = .103$, respectively.

Overall, the mean ages for first offence for rural and urban offenders did not differ substantially from each other in either sample; hence there was no corresponding significant main effect in the global ANOVAs, and no obvious support for the hypothesis that urban offenders would be younger at the time of their first offence than rural offenders. As Table 6.2 shows, when broken down according to urban and rural categories and gender, the mean ages were again similar across the urban and rural samples. However, once again, there were no corresponding significant interactions in the global ANOVAs; i.e. there were no significant trends between categories beyond the general finding that the female offenders were consistently older at the time of their first offence than their male counterparts.

Nevertheless, differences in the mean ages for the both males and females in the rural and urban settings were not reflected in their modes, which suggests that the samples were not normally distributed (see Table 6.2). To investigate this further, histograms of age distribution were produced for the two samples with regard to age and locality for the two data sets ($N = 540, n = 355$) (see figures 6.2a to 6.2l in Appendix 2). As reflected in the findings reported earlier (see figures 6.1c, 6.1d, 6.1d, 6.1f in Appendix 2), whereas the male

age distributions in both data sets, in both rural and urban areas, show simple positively skewed distributions, the female distributions show a tendency towards bimodality. Hence, like their male counterparts, we see a cluster of female arsonists whose first offence was in their middle and late teenage years; however, there is a second cluster of female arsonists who started in their late 30s and early 40s.

6.4.4. Gender and Age of Single and Serial Offenders

In accordance with the definition proposed in Chapter 2, offenders were coded as serial arsonists if they had set fires on two or more separate occasions, and single arsonists, if they had been reported as offending on only one occasion during the period under scrutiny. This presented something of an issue as an examination of the records of the smaller subset of 355 revealed that some subjects had a history of offending before the time period sampled; whereas equivalent data were not available for the remaining 185 offenders. In the first instance, therefore, to aid comparability between the smaller subset (355) and the full sample (540), the same criteria were used based on the information common to all 540 offenders; i.e. in this study, individuals were categorised as serial offenders if they had a record of other arson offences within the period of 2002 to 2010 (n.b. in later analyses on the smaller sample, convictions prior to this period were also included).

Results are shown in Table 6.3. In the total sample ($N = 540$), 82% were categorised single offenders, and 18% as serial offenders. In the smaller sample, ($n = 355$) 79% were single offenders and 21% serial offenders. Clearly, as predicted, in both samples, single offenders predominated (Binomial tests, $p < .0001$).

Table 6.3: Descriptive statistics by Gender and Single and Serial Offenders

			<i>N</i>	Median	Mode	Mean (<i>SD</i>)	Percentage	Range
Offenders (<i>N</i> = 540)	Single	Total	445	15	14	21.35 (12.99)	100	61 (6 – 67)
		Male	386	15	14	20.17 (11.60)	87	58 (6 – 64)
		Female	59	20	14	29.08 (18.15)	13	59 (8 – 67)
	Serial	Total	95	19	15	23.87 (12.52)	100	57 (6 – 63)
		Male	84	19	15	22.87 (11.88)	88	57 (6 – 63)
		Female	11	40	42	31.55 (15.09)	12	43 (12 – 55)
Offenders (<i>n</i> = 355)	Single	Total	280	14	14	20.48 (13.02)	100	60 (7 – 67)
		Male	236	14	14	19.01 (11.27)	84	56 (7 – 63)
		Female	44	19	14	28.34 (18.20)	16	59 (8 – 67)
	Serial	Total	75	19	15*	24.25 (12.98)	100	57 (6 – 63)
		Male	65	19	15*	23.26 (12.33)	83	57 (6 – 63)
		Female	10	31	12*	30.70 (15.84)	17	45 (12 – 57)

* Multiple modes exist. Smallest mode is shown.

In relation to gender, in the total data set (*N* = 540), of the 445 single offenders 87% were males and 13% females; and of the serial offenders, 88% were males compared to 12% females. In the smaller sample (*n* = 355), of the single offenders 84% were males and 16% females, and of the serial offenders in the same sample 83% were males and 17% females. In other words, the proportions were roughly similar in all cases and males predominated (Binomial test, $p < .0001$ in all cases).

Again, therefore, the gender ratio was similar to other samples of arsonists cited in the literature; i.e. only 10 to 15% of the offenders were females. There were also no significant differences in these ratios between the rural and urban samples; $\Phi(540) = -.019$, $p = .658$; $\Phi(355) = -.027$, $p = .610$, respectively.

With regard to age of first offence, again, given the overall main effect for gender in the global ANOVAs, females tended to be older in all categories when committing their first offence. There was also a trend across both samples for serial offenders to be older than single offenders, but as mentioned, the global ANOVAs showed no significant age effects or interactions regarding single and serial offending. Consequently there was no definitive

support for the hypothesis that serial offenders would start fire-setting at a later age, though there was a trend in this direction.

Once again, the modes and means appeared to be discrepant, especially for females, so to provide a more detailed overview of the distributions, histograms were produced (see figure 6.3a to 6.3l in Appendix 3). The now familiar trend towards a bimodal distribution for females can again be detected in the distributions (see figures 6.3g, 6.3h, 6.3k and 6.3l in Appendix 3).

6.4.5. Results: Gender and Age of Single and Serial Offenders in Rural and Urban Areas

In this next section, the data are further broken down according to the three independent variables of age, urban/rural and single/serial (see Table 6.4).

In the larger sample of 540 offenders, of the urban offenders, 12% were single female offenders and 2% were serial female offenders, with 67% single male offenders and 19% serial male offenders. Similarly, of the rural offenders, 10% were single female offenders and 1% serial female offenders, and 76% were single male offenders and 13% were serial male offenders. Thus again, the proportions were very similar in all cases with males and single offenders predominating (Binomial test, $p < .01$ in all cases). Moreover, when Phi Coefficients were calculated for the relevant 2 x 2 frequency comparisons for both samples (urban single male/female versus rural single male/female; rural serial male/female versus rural serial male/female etc.), none approached significance ($p > .10$).

The same was the case for the urban sample in the smaller data sample ($n = 355$); i.e. 16% were female single offenders, and 3% were female serial offenders, and 59% were male single offenders and 22% were male serial offenders. In the rural sample in the smaller data set, 11% were female single offenders, 4% female serial offenders, 70% male single offenders and 16% male serial offenders (Binomial tests, $p < .005$ in all cases). In common

with other findings, the proportions were very similar, with males and single offenders predominating. Again, Phi Coefficients for the relevant 2 x 2 frequency comparisons for both samples (urban single male/female versus rural single male/female; rural serial male/female versus urban serial male/female etc.) did not approach significance ($p > .10$).

Table 6.4: Descriptive statistics by Gender and Single and Serial Offenders in Urban and Rural Areas

				<i>N</i>	Med	Mode	Mean	Percentage	Range
Offenders (<i>N</i> = 540)	Urban	Single	Male	191	14	14	18.84 (10.91)	67	58 (6 – 64)
			Female	33	24	14	31.45 (19.85)	12	59 (8 – 67)
	Serial	Male	Male	53	17	15*	22.42 (12.52)	17	57 (6 – 63)
			Female	7	40	12*	32.29 (17.04)	2	43 (12 – 55)
	Rural	Single	Male	194	16	14	21.53 (12.12)	76	57 (6 – 63)
			Female	26	17	14	26.08 (15.58)	10	46 (10 – 56)
		Serial	Male	32	20	15*	23.59 (10.92)	13	39 (11 – 50)
			Female	4	32	16*	30.25 (13.23)	1	26 (16 – 42)
Offenders (<i>n</i> = 355)	Urban	Single	Male	83	13	14	14.98 (7.27)	58	38 (7 – 45)
			Female	22	17	13	29.59 (20.69)	15	59 (8 – 67)
	Serial	Male	Male	32	17	15	20.31 (11.84)	23	57 (6 – 63)
			Female	5	20	12*	29.20 (20.22)	4	45 (12 – 57)
	Rural	Single	Male	153	15	14	21.20 (12.41)	72	56 (7 – 63)
			Female	22	20	14	27.09 (15.71)	10	44 (12 – 56)
		Serial	Male	32	23	13	26.41 (12.38)	15	41 (12 – 53)
			Female	5	40	16*	32.20 (12.26)	2	26 (16 – 42)

* Multiple modes exist. Smallest mode is shown.

An examination of the results for age of first offence broadly echoed those found in the previous sections. It can be noted that in the global ANOVAs for both samples, other than a main effect for age, none of the other main effects or interactions was significant. This would indicate that, in general, the pattern for females to be older than males is repeated in all categories, for both samples. Once again, the modes were somewhat discrepant with the means; as before, therefore, histograms were produced (see Appendix 4). Once again, an overall positive skew was found, and there was some tendency for the female distributions to appear bimodal, with a smaller cluster of older offenders.

6.5. Discussion and Conclusion

To summarize, as hypothesised, in the present overall sample of Danish offenders the large majority of arsonists were male; moreover, the gender ratio of between 85% and 90% males is consistent with findings in previous studies from other countries (see, for example, Bourget & Bradford, 1989; Fineman, 1980; Hakkanen et al., 2004; Heath et al., 1985; Santtila et al., 2003; Sapp et al., 1994; Snyder, 2008; Stewart, 1993; U.S. Department of Justice, 2001; Wachi et al., 2007; Wooden & Berkley, 1984). Significantly, this gender ratio was found not only in the overall sample, and the smaller subset, but showed up consistently across a variety of different subgroups and corresponding data splits (rural and urban males and females, single and serial males and females, etc.).

There was also support for the hypothesis that the majority of the arsonists would be young (i.e. 18 years or younger) at the time of their first offence (see for example, Burton et al., 2012; Edwards & Grace, 2007, 2014; Hakkanen et al., 2004; Santtila et al., 2003; Snyder, 1999; Snyder, 2008), but, on average, male offenders would be significantly younger than female arsonists in this respect (Dickens et al., 2014). Interestingly, the overall difference in the means appeared to disguise the fact that the female arsonists tended to be a more diverse group. Thus, although most female arsonists were also adolescent at the time of their first offence, there was also an additional subgroup or cluster of older offenders in their 30s and 40s, not as evident in the male sample. This bimodal peak was repeated in all the subgroups of female arsonists studied; i.e. it existed no matter how the data were cut or split. Potentially, this is a significant finding, which will be considered further shortly, but for now it suggests that generalisations about gender in relation to age differences in arson, and related interpretations, may be highly misleading without consideration of the nature of the age profiles.

The fact that a general gender imbalance with regard to frequency of offending is not surprising given that, as mentioned in Chapter 2, in terms of offending generally, males have been found to offend at a much higher rate than females in almost every country in which studies on criminal careers have been conducted. As noted earlier, some studies tend to suggest that the proportion of female offenders is increasing (Burton et al., 2012; Dickens et al., 2014), particularly for more violent crimes (Holmes, 2010); but it still remains the case that females have lower arrest rates than males for virtually all crime categories except prostitution and shoplifting (Bennett, Farrington, & Huesmann, 2005; Feldman, 1993; Flowers, 2003; Steffensmeier & Allan, 1996). Moreover, as yet, there is no generally accepted explanation as to why this gender disparity exists (Gannon, 2010). Given that most crimes are not violent in nature, it has been argued that the general trend cannot be due to physical differences, such as males having a ‘mesomorphic’ body type, or greater biological propensities for aggression. Another possibility is that females develop social and cognitive skills earlier in life and have better prosocial skills (Bennett et al., 2005). However, such factors may, in turn, be influenced by gender roles on behaviour. For example, a variety of evidence indicates that male criminal behaviour may be facilitated by culturally derived ‘machismo’ beliefs and attitudes that encourage males to engage in more risky and confrontational behaviours to demonstrate their male prowess. As such they may then facilitate offending as an outlet for other influences such as anger, boredom and frustration; and this may be particularly evident in the individual’s younger years (Flowers, 2003). Nevertheless, some younger females do offend, thus if we accept that gender roles have influence, then presumably we must assume that females may have different motives for offending. It is perhaps this possibility that may help provide some insight into the present findings regarding arson, particularly those for age.

A variety of evidence suggests that different family gender cultures often result in girls being more tied and closely connected to their family. For example, studies show that parents are more likely to exert direct control over their daughters, in comparison to their sons (Graham & Bowling, 1995; Hagan, Gillis & Simpson., 1985; Junger-Tas & Terlouw, 1991; Rankin & Kern, 1994). In the Netherlands, in 1990, twice as many boys than girls went out at weekends, while girls spent the majority of their time carrying out household chores and babysitting younger children (Junger-Tas & Terlouw, 1991). Another study showed that before the age of six, girls were only allowed to play within the direct vicinity of their homes, while boys of the same age were allowed to venture out much further (Masson, Kayotis, & de Jong, 2002). These studies suggest that there are different rules and expectations for girls as opposed to boys, which also influence how the individual, as well as society, views the two sexes. However, these different gender cultures may also tend to make females more vulnerable if family connections are dysfunctional; i.e. females appear, in general, to react more negatively to a destructive family environment (Steketee et al, 2013).

With regard to arson specifically, it could be argued, therefore, that while males might be more inclined to commit arson offences in their younger years because of factors such as generalised risk-taking, stimulation, frustration, machismo etc., younger females in their mid and late teen years may be reacting more specifically to a dysfunctional home environment. In support of this, a number of studies have shown females are most likely to set fire to properties in which they have an emotional investment (Bourget & Bradford, 1989; Burton et al., 2012; Harmon et al., 1985), whereas males are more likely to set fires out of anger, frustration, boredom, vandalism and/or crime concealment (Bourget, & Bradford, 1989; Lewis & Yarnell, 1951; Sapp, Hobort et al., 1994). This is not to say, of course, that a dysfunctional home environment would not affect males, but rather the influence may be greater for females. As such, this may account for the existence of the second subgroup of

female offenders in their late thirties and early forties, who could be *adult women reacting to dysfunction in their own homes* (marital issues, child care issues, etc.).

In the present study it was also hypothesised that, for a variety of reasons, such as opportunities, types of buildings, and population density, there would be more urban than rural offenders. As noted in Chapters 3 and 4, although the effects of location have not been investigated systematically in relation to arson, there are some indications there may be more crime, in general, in urban areas compared to rural areas (Ladbroke, 1988; NCVRW, 2013; Weisheit, Falcone & Wells, 1999). However, the present findings regarding this were contradictory; the results for the larger (540) and smaller (355) samples were both significant, but in opposite directions. In the larger sample there were more urban offenders than rural offenders, whereas in the smaller subset, there were more rural offenders than urban offenders. The reasons for this are not clear, however it will be remembered that the 355 subset of offenders were selected solely because they could be matched with the full sample and additional data were available for them. If it were the case, that as a group, the selected rural police stations were more likely to hold more accurate and comprehensive records than the urban stations (perhaps, for example, because there were more of them, and relative to the number and type of criminal cases they had to deal with, they were relatively better resourced), this would result in more cases being available for the rural area than the urban area, and erroneously give the impression that there were more arsonists in the rural area. Should this be the case, it is only the larger sample (540) that can give an accurate representation of the proportions of offenders in the rural and urban areas; and, if so, the hypothesis that there would be more arsonists in urban areas could be viewed as supported.

Nevertheless, this raises the issue of whether any such bias is likely to have affected the results for other variables investigated using the 355 subset. However, given that was no evidence of any interactions between rural and urban, and the main variables investigated so

far in either of the two samples (540 and 355), there would appear to be no reason to expect a problem. Also, this issue would not be expected to affect any analysis of proportions *within* the district subgroups (such as the relative proportions of males to females in urban and rural areas), or differences in means (such as age) between the groups, as for the most part, so long as there are enough cases to make such inferences meaningful, these kinds of calculations should not be directly affected by sample size.

The hypothesis that, for similar reasons (opportunities etc.), the urban offenders would be younger at the time of their first offence (start fires earlier) than rural offenders was not supported (as just noted, as age is based on mean estimates, the findings should not be affected by differences in sample sizes between the two districts). This contradicts Perryman's (2016) findings. However, there are a variety of reasons that might account for this. For example, the primary motivation for arson may have differed in the two districts. Thus, fire-setting in the urban area may have been mostly facilitated by factors such as the presence of opportunities, inviting and vulnerable targets, and peer pressure; whereas, in the rural area this may have been counteracted by a greater inclination to offend because of factors such as frustration and boredom associated with an absence of social activities for the younger population. The absence of opportunities to engage in social and recreational activities, such as sport, has been shown to have an impact on offending (see, for example, Morris, Sallybanks, Willis, & Makkai, 2003). If so, the availability of alternative social activities and recreational distractions may be an important factor to consider when comparing rates of arson in different districts. However, whatever the case, the urban / rural distinction as represented in the present sample, did not significantly predict age of first offence.

Likewise, there was no clear support for the hypothesis that serial offenders would start setting fires later than their single (one-time offence) counterparts, as might be predicted

from some reports (see, for example, Edwards & Grace, 2007; Eidsson, 2005; Sapp, Hobort et al., 1994; Waschi et al., 2007). However, there was a non-significant trend in this direction. This is potentially an interesting trend given that, as noted in Chapter 4, in the wider literature on offending, there seems to be a general consensus that those offending earlier are more likely to commit more crimes and have longer careers (Blumstein et al., 1986; Elliot, 1994; Farrington et al., 1990; Gittens, 2011; LeBlanc & Loeber, 1998; Loeber & Le Blanc, 1990; Snyder, 1998; Tolan, 1987). One possible explanation here is that arson may differ from other serious crimes in that often those involved are single offenders who may be influenced primarily by momentary impulse or opportunism, perhaps as a result of boredom. However, serial firesetters may be motivated most by relatively more stable factors, such as repeated attempts to achieve a sense of power in situations where they feel they have none, or a desire to exact revenge. Consequently, as the latter motives have been associated more with older offenders, one might expect serial arsonists to be older at the time of their first offence (see for example; Eidsson, 2005).

One very clear finding, in line with predictions, was that single offenders predominated over serial offenders, and single offenders were younger at the time of their first offence. Again, these differences between single and serial offending may reflect the influence of different motivations. The rationale would be that, if a central feature of crimes of arson is that they are most often committed by young people, and are more likely to be opportunistic and committed in the spur of the moment for excitement or stimulation, one might expect individuals committing 'one-off' opportunistic crimes (single offenders) to be more prevalent and to commit such acts at a younger age than those whose offending may be related to more stable characteristics, such as a desire for revenge or financial gain (see, for example, Grant & Kim, 2007).

However, there is a methodological point that may be worth airing here that has been, more or less ignored in the literature; in a ‘snapshot’ of particular sample at a particular time, it is possible that some offenders who have no previous history of offending may go on to offend after the end of the sampled time period. Hence, it would be misleading to categorise them as ‘single offenders’ and a time sampling method may overestimate the number of single offenders. This is, of course, very possible, but how might it actually affect the results? On the basis of basic probability theory, over an eight year period, even if the likelihood of picking only the first offence for each serial offender were as high as 50%, the likelihood of doing this for even 10 offenders would be extremely small ($< 0.10\%$), and for any sizeable proportion of the 255 ‘single offenders’ here, it would be miniscule. In other words, it is extremely unlikely that any such effect would have had any systematic influence on the results presented here.

Finally, with the exception of the rural/urban distinction, discussed above, results for the full data sample and the smaller subset were remarkably comparable with regard to all the variables investigated. Taken together, these results suggest that the smaller subset may be reasonably representative of the larger population sample. This is crucial given that, for many of the variables investigated in the following chapters, data was only available for the smaller subset.

Chapter 7

Study 2 – Further Demographic and Biographical Characteristics of Arsonists: Psychiatric and Criminal history, Educational, Domestic and Employment status, Nationality and Ethnicity

7.1. Introduction

This chapter considers further demographic and biographical characteristics of the sample that have been identified in the literature as having particular relevance to arson; these are psychiatric and criminal history, educational, domestic and employment status, and nationality and ethnicity. However, solo versus group offending is also added to the following analyses; although technically this is more a behavioural variable than a demographic variable, it was included because it has most often been studied in terms of its demographic correlates, and the present analysis provided an opportunity to examine some related hypotheses.

As noted in the previous chapter, because the literature on demographic characteristics of arson has been dominated by relationships with age and gender, as well as providing basic frequency information, all of the above variables were considered statistically primarily in terms of their breakdown according to age and gender. Details for variables were only available for the smaller subset of 355 offenders, so this smaller sample was used for all

the analyses in this chapter (For a summary of the codings of variables used in this chapter see Appendix 1).

7.2. Hypotheses

Hypotheses involving the demographic and biographical variables described in this chapter were as follows.

1. The majority of offenders will be White, live with their parents, be unemployed, have a history of disruptive behaviour, adjustment and alcohol issues, and mental health problems (psychiatric history).

2. The majority of arsonists will have previous convictions for arson and other offences.

3. Compared to female offenders, male offenders will be more likely to have alcohol abuse issues, and be unemployed.

4. Compared to solo offenders, arsonists operating as a group will be younger, and have a history of disruptive behaviour and have adjustment issues, while solo offenders will be more likely to have a psychiatric history and will be or have been enrolled in school at the time of their most recent offence.

7.3. Results

7.3.1. Psychiatric History

Offenders were coded as having a psychiatric history if on their record it was stated that they had been diagnosed with a disorder and/or had had continued contact with a mental health professional at the time of any of their offences. The results for psychiatric history according to age and gender are shown in table 7.2. *Please note again that in all the following tables, the median, mode, mean and range refer to age of first offence.*

Only a minority (22 percent) had a record of having been diagnosed with a disorder and/or had continued contact with a mental health professional; the remaining 78 percent had not. The difference was significant (Binomial test $p < .001$). The hypothesis that most offenders would have a psychiatric history of some kind was not, therefore, supported. Of the offenders who had no psychiatric history, 90 percent were males and 10 percent were females; whereas for those who had a history, 67 percent were males and 33 percent females; so again males predominated in both categories (Binomial tests $p < .003$). However, there were proportionally more females in the psychiatric history category (10 percent versus 33 percent), $\Phi(355) = .264$ $p < .0001$.

Table 7.1: Descriptive Statistics for Psychiatric History by Gender

		<i>N</i>	Median	Mode	Mean (SD)	Percentage	Range
Offenders with no psychiatric history	Total	276	14	14	17.53 (9.93)	78	57 (6 – 63)
	Male	248	14	14	17.37 (9.51)	90	57 (6 – 63)
	Female	28	14	13	18.96 (13.21)	10	49 (8 – 57)
Offenders with psychiatric history	Total	79	33	41	34.35 (14.37)	22	58 (9 – 67)
	Male	53	31	15*	31.91 (13.09)	67	54 (9 – 63)
	Female	26	41	41	39.35 (15.79)	33	53 (14 – 67)

*Multiple modes exist. Lowest mode is shown.

An ANOVA on the age at first offence data found the usual significant main effect for gender, $F(1,351) = 7.00$, $p < .001$, $\eta^2_p = .020$; i.e. overall females were older than males. However, a significant main effect was also found for psychiatric history, $F(1, 351) = 104.52$, $p < .001$, $\eta^2_p = .229$; offenders with a psychiatric history were significantly older at first offence than offenders without a psychiatric history. However, the interaction just failed to reach significance, $F(1,351) = 2.93$, $p = .088$, $\eta^2_p = .008$. An examination of the means showed a trend for females with psychiatric history to be older at the time of their first offence than males in this category, but for there to be far less difference for offenders with no history.

A breakdown of disorders (taken directly from police records) according to age at first offence and gender for the 79 offenders with a psychiatric history is shown in Table 7.3. All were binary coded (present/absent). As offenders frequently had diagnoses in more than one category it was not possible to compare categories using inferential statistics; however, the most obvious observations are that alcohol abuse was the most frequently reported disorder (19 percent), whereas the frequency of other disorders was 10 percent or less. Accordingly, however, there was no clear evidence that any of the disorders were present in most offenders and, thereby, no support for the hypothesis that the majority of offenders would be have a history of alcohol issues.

As usual, males predominated in the following categories (Binomial tests); psychosis ($p = .036$), personality disorder ($p < .001$), and alcohol abuse ($p < .0001$); however, no significant gender differences were found for depression and suicide ($p > .05$). In other words, compared to the other variables, female arsonists were proportionally more often represented in the depression and suicide categories.

Table 7.2: Descriptive Statistics for Psychiatric History by Gender

		<i>N</i>	Median	Mode	Mean (<i>SD</i>)	Percentage	Range
Depression	Total	35	41	41	38.83 (13.32)	10	55 (12 – 67)
	Male	18	33	29*	33.22 (10.90)	51	37 (12 – 49)
	Female	17	41	41	44.76 (13.34)	49	47 (20 – 67)
Psychosis	Total	28	38	19*	37.07 (12.74)	8	44 (19 – 63)
	Male	20	39	19*	38.40 (13.68)	71	44 (19 – 63)
	Female	8	36	24*	33.75 (10.04)	29	28 (20 – 48)
Personality Disorder	Total	23	31	14*	31.39 (14.08)	6	43 (14 – 57)
	Male	17	31	31	29.71(11.52)	74	35 (14 – 49)
	Female	6	38	14*	36.17 (20.27)	26	43 (14 – 57)
Suicide	Total	28	33	33	35.11 (11.99)	8	42 (15 – 57)
	Male	18	31.5	33	31.22 (9.41)	64	34 (15 – 49)
	Female	10	44.5	16*	42.10 (13.39)	36	41 (16 – 57)
Alcohol	Total	68	29.5	19	31.88 (13.33)	19	53 (14 – 67)
	Male	54	28.5	19	29.59 (11.30)	79	40 (14 – 54)
	Female	14	44	16*	40.71 (17.02)	21	53 (14 – 67)

*Multiple modes exist – lowest mode is shown.

The gender ratio within the subgroup of offenders with alcohol abuse issues was very similar to the gender ratio in arson overall, and there was no support for the hypothesis that male offenders were more likely than female offenders to have alcohol issues, $\Phi(355) = -.070, p = .174$. In fact, the proportion of females was slightly higher among this particular subgroup.

Mean ages for gender within the psychiatric subgroups were analysed using Welch t tests. Females were significantly older than males for suicide, $t(26) = 2.25, p = .018$; general psychiatric history, $t(66) = 2.24, p = .029$, and alcohol abuse problems, $t(66) = 2.94, p = .005$. None of the other comparisons was significant ($p > .05$). Also, in line with the overall findings in Table 7.3, point biserial correlations showed that those with a history of these disorders were highly significantly older at the time of their first offence than those without in every case, $r_{pb} = .20$ to $.44, p < .0001$.

7.3.2. Criminal Record/Previous Convictions

Results for previous recorded convictions (i.e. any kind of offence committed before the most recent arson offence) according to age and gender are shown in Table 7.3. Results showed approximately 50 percent of the sample had previous convictions (including arson). There was no support, therefore, for the hypothesis that the majority of arsonists will have previous convictions for arson and other offences. In the 'no criminal record category', the standard ratio of 83 percent males to 17 percent females was evident, similarly in the criminal record category; i.e. 86 percent males and 14 percent females (Binomial tests, $p < .001$). The difference between those with and without previous convictions was not statistically significant, $\Phi(355) = -.042, p = .429$.

An ANOVA on the age data found the usual main effect for gender, $F(1,351) = 25.43, p < .001, \eta^2_p = .068$; i.e. overall females were older than males. However, a significant

main effect was also found for previous/no previous convictions, $F(1,351) = 12.90, p < .001, \eta^2_p = .035$; offenders with a criminal record were significantly older in terms of the age of their first offence. However, the interaction with gender was not significant in this respect, $F(1, 351) = 0.135, p = .714, \eta^2_p = .0001$.

Table 7.3: Descriptive Statistics for Criminal Record/Previous Convictions by Gender

		<i>N</i>	Median	Mode	Mean (<i>SD</i>)	Percentage	Range
Previous Convictions	Total	179	19	13	24.62 (13.13)	50	61 (6 - 67)
	Male	154	19	13	23.44 (11.78)	86	57 (6 - 63)
	Female	25	24	13	31.92 (18.15)	14	54 (13 - 67)
No previous Convictions	Total	176	14	14	17.87 (12.16)	50	61 (6 - 67)
	Male	147	14	14	16.25 (10.26)	83	57 (6 - 63)
	Female	29	17	12*	26.07 (17.09)	17	58 (8 - 66)

*Multiple modes exist. Lowest mode is shown.

The breakdown for different subgroups of offences is shown in Table 7.4. All were binary coded (present/absent). Due to the large number of types of offences reported, the table refers only to the main categories; i.e. those that have numbers large enough to enable meaningful statistical inferences to be drawn. It will be noted, of course, that ‘previous convictions for arson’ corresponds to single versus serial arson; i.e. those with previous convictions for arson were effectively serial arsonists. As mentioned in the last chapter, the records of the smaller subset of 355 revealed that some of them had a history of offending before the time period sampled, whereas equivalent data were not available for the remaining 185 offenders. Consequently, for consistency in comparing samples, categorisations in Study 1 were based on offences within the selected period (2002-2010). However, when, as here, offences previous to this period were taken into consideration for the smaller subset, perhaps not surprisingly, the proportion of serial arson offenders rose from 21 percent to 28 percent; nevertheless, serial offenders were still very significantly in the minority (Binomial Test, $p < .0001$).

As offenders frequently had convictions in more than one category, again it was not possible to compare categories using inferential statistics; however, the key observations are that arson (28 percent), and theft (21 percent), were the most frequently reported convictions; all of the rest ranged between 8-11 percent. Notably, 35 percent of offenders had no prior arson convictions (were single offenders), but did have a criminal record for other offences.

Table 7.4: Descriptive Statistics for Types of Previous Conviction by Gender

Previous Convictions		<i>N</i>	Median	Mode	Mean (<i>SD</i>)	Percentage	Range
Total other than arson	Total	126	22	13	24.79 (12.51)	35	60 (7 – 67)
	Male	110	22	13	24.06 (11.37)	87	56 (7 – 63)
	Female	16	20.5	13	29.75 (18.30)	13	54 (13 – 67)
Arson	Total	100	18	13	24.02 (12.97)	28	61 (6 – 67)
	Male	84	17.5	17	22.68 (12.27)	84	57 (6 – 63)
	Female	16	21	13	31.06 (19.80)	16	54 (13 – 67)
Theft	Total	76	19	13	22.32 (11.77)	21	60 (7 – 67)
	Male	67	20	13	22.18 (10.58)	88	42 (7 – 49)
	Female	9	14	13*	23.33 (19.36)	12	54 (13 – 67)
Burglary	Total	40	15	13	19.90 (11.19)	11	57 (10 – 67)
	Male	36	15	13	19.06 (8.51)	90	31 (10 – 41)
	Female	4	15	13	27.50 (26.40)	10	54 (13 – 67)
TWOC ¹	Total	31	18	17	22.16 (11.64)	9	55 (12 – 67)
	Male	28	19	17*	21.07 (8.41)	90	34 (12 – 46)
	Female	3	17	13*	32.33 (30.09)	10	54 (13 – 67)
Traffic	Total	34	21.5	17	27.32 (13.88)	10	55 (12 – 67)
	Male	30	20	17	25.40 (11.66)	88	37 (12 – 49)
	Female	4	43.5	13*	41.75 (22.17)	12	54 (13 – 67)
Drugs	Total	27	19	13	24.07 (13.06)	8	55 (12 – 67)
	Male	24	19	12*	21.92 (9.23)	89	29 (12 – 41)
	Female	3	44	13*	41.33 (27.10)	11	54 (13 – 67)
Criminal Damage	Total	41	18	13	23.66 (12.86)	12	55 (12 – 67)
	Male	39	18	13	22.82 (11.00)	95	37 (12 – 49)
	Female	2	40	13*	40.00 (38.18)	5	54 (13 – 67)
Assault	Total	33	25	12*	29.42 (15.29)	11	55 (12 – 67)
	Male	26	27	12*	28.46 (13.36)	79	51 (12 – 63)
	Female	7	24	14	33.00 (22.02)	21	54 (13 – 67)
Public Disorder	Total	28	27	13	28.07 (15.46)	8	55 (12 – 67)
	Male	24	23.5	12*	25.58 (13.05)	86	40 (12 – 52)
	Female	4	46	13*	43.00 (22.38)	14	54 (13 – 67)
Deception	Total	22	23	12*	27.23 (15.16)	6	55 (12 – 67)
	Male	18	23	12*	23.50 (10.60)	81	34 (12 – 46)
	Female	4	48	13*	44.00 (22.66)	19	54 (13 – 67)

*Multiple modes exist. Lowest mode is shown.

¹TWOC: Taking without owners consent. Usually theft of car or vehicle.

Binomial tests were run to examine differences in gender ratios for the various subgroups. Again, as predicted, males significantly predominated in all categories; i.e. total convictions other than arson ($p < .0001$), arson ($p < .001$), traffic violations ($p < .001$), deception ($p = .004$), theft ($p < .001$), burglary ($p < .001$), TWOC ($p < .001$), drugs ($p < .001$), criminal damage ($p < .001$), assault ($p = .001$), public disorder ($p < .001$). Moreover, all fell within the standard range of 84-90 percent males to 16-10 percent females, with the exception of assault, where the proportion of females percent was slightly higher (21 percent), but not significantly so; $\Phi(355) = -.053, p = .314$.

Point biserial correlations (r_{pb}) between age and each of the categories ($n = 355$) showed that those with convictions in the following categories were significantly older than those without convictions: Arson, $.13, p = .013$; Assault, $.20, p < .0001$; Deception, $.12, p = .027$, Public Disturbance, $.15, p = .004$; and traffic, $.15, p < .004$. None of the other correlations was significant ($p > .05$). Notably, the result for arson here (which included convictions before 2002) indicates clearer support for the hypothesis from Study 1 that the later the offenders started their careers, the more arson offences they will have committed.

Welch t tests found that females were significantly older at the time of their first offence for arson $t(98) = 1.17, p = .027$, traffic violations, $t(32) = 2.36, p = .023$, deception, $t(20) = 2.82, p = .012$, drugs, $t(25) = 2.71, p = .012$, and public disorder, $t(26) = 2.23, p = .034$. For the remaining criminal subgroups no significant age difference were found ($p > .10$). A t test could not be run on burglary, as sample sizes for females was too small; however, in all cases, females were, on average, older.

7.3.3. Educational and Domestic Status

The results for educational and domestic status are shown in Table 7.5. Offenders were coded as 1 (present) if the category label was associated with any of their arson offences, and 0

(absent) if it was not associated with any of their offences. Again, most offenders were single offenders; for the large majority of offenders this was also their status at the time of their most recent and only offence. Because of the limited data available on qualifications, it was only possible to code whether individuals had higher educational qualifications. Likewise, surprisingly, with the exception of divorce, the offender's marital and/or relationship status was so rarely mentioned in records that it was not included as a variable.

Most offenders had committed offences while still at school (55 percent), and living with parents (59 percent). Binomial tests showed that, as a proportions of the sample total, these were statistically significant ($p < .05$, and $p < .001$, respectively). This supports the hypothesis that most offenders would be living with parents, at least at the time of their first offence. In both these categories, the typical overall gender ratio of 88-89 percent males, 12-11 percent females was evident ($p < .0001$). These data can be considered even more pertinent, because, given the relevant data were not always recorded in individual cases, these majority proportions may underrepresent the actual state of affairs.

The other categories showed proportionately far fewer individuals relative to the overall sample. With regard to higher educational qualifications, of the 4 percent of the sample reported as having higher educational qualifications, all were males. Only a small number of offenders (14 percent) had experienced some sort of trouble in school (this would be coded as present if the offender had any history of behavioural or academic issues at school). Of these, the standard proportion of 83 percent males and 17 percent females was found (Binomial test, $p < .0001$). However, of the minority (11 percent) who had offended while living in an institution, interestingly, of these, 26 percent were females. This meant that, although males still dominated, the proportion of females (26 percent) who were or had been living in an institution was significantly higher than those living with parents (11

percent), $\Phi = .41$, $p < .0001$, and there was a near significant trend for proportionally more females than males to have been living in an institution, $\Phi = -.10$, $p = .055$.

Table 7.5: Educational and Domestic Status by Gender ($n = 355$)

Status		<i>N</i>	<i>Median</i>	<i>Mode</i>	<i>Mean (SD)</i>	<i>Percentage</i>	<i>Range</i>
Living with parents	Total	208	13	14	13.83 (5.17)	59	44 (6 – 50)
	Male	185	13	14	13.84 (5.78)	89	44 (6 – 50)
	Female	23	13	13*	13.74 (3.19)	11	17 (8 – 25)
Still at school	Total	197	13	14	13.47 (4.54)	55	44 (6 – 50)
	Male	174	13	14	13.43(4.67)	88	44 (6 – 50)
	Female	23	13	13	13.83 (3.39)	12	17 (8 – 25)
Trouble at school	Total	48	19	14	21.65 (10.94)	14	49 (8 – 57)
	Male	40	19	14	20.60 (8.66)	83	44 (13 – 57)
	Female	8	18	13*	26.88 (18.64)	17	44 (13 – 57)
Higher qualifications	Total	15	26	18*	31.80 (15.35)	4	47 (16 – 63)
	Male	15	26	18*	31.80 (15.35)	100	47 (16 – 63)
	Female	0	-	-	-	-	-
Institution	Total	39	26	17*	30.05 (14.75)	11	53 (10 – 63)
	Male	29	26	46	29.93 (15.44)	74	53 (10 – 63)
	Female	10	29	16*	30.40 (13.29)	26	35 (16 – 51)
Recently divorced	Total	19	39	39	36.95 (11.00)	5	40 (17 – 57)
	Male	13	33	33*	33.00 (8.18)	68	27 (17 – 44)
	Female	6	48	25*	45.50 (12.13)	32	32 (25 – 57)

*Multiple modes exist. Lowest mode is shown.

As might be expected, only a small minority of offenders were reported as having been divorced in the 6 months preceding an offence (5 percent). Of these, 68 percent were males and 32 percent females. Though the small frequencies make comparisons difficult, it is interesting to note that these proportions still differ significantly from the more typical 89/11 gender ratio as shown in the ‘living with parents’ category ($\Phi = .17$, $p < .02$). That is, females were proportionally represented more often than usual in the ‘recently divorced’ as well as the ‘living in an institution’ categories.

With regard to age of first offence, point biserial correlations (r_{pb}) between age and each of the categories showed that those who had offended while living with parents and still at school were significantly younger than those who were not ($-.68$, $p < .0001$, in both cases),

whereas those living or having lived in an institution, having a history of trouble at school, and recently divorced, were older at the time of their first offence than those not in these categories (.24 $p < .0001$, .17 $p = .001$, and .29 $p < .0001$, respectively). Welch t tests showed that females who had been recently divorced before offending were older at the time of first offence than males, $t(17) = 2.66$, $p = .016$, whereas there were found no significant age differences between male and female offenders in the remaining subgroups ($p > .10$).

7.3.4. Employment Status

The data ($n = 355$) for employment status (employed/unemployed) in relation to gender and age are summarised in Table 7.6. Offenders were coded as unemployed if they had been unemployed at the time of any of their offences, and employed if they had never been unemployed at the time of any of their offences. As predicted, the majority of offenders (73 percent) had a record of being unemployed while offending (and for most this would be at the time they committed their last offence), Binomial test, $p < .001$.

Table 7.6: Descriptive Statistics for Employment Status by Gender

		<i>N</i>	Median	Mode	Mean (<i>SD</i>)	Percentage	Range
Unemployed	Total	258	14	14	19.95 (13.25)	73	61 (6 – 67)
	Male	214	14	14	18.22 (11.24)	83	57 (6 – 63)
	Female	44	18.5	13	28.39 (18.29)	17	59 (8 – 67)
Employed	Total	97	22	14*	24.78 (12.02)	27	56 (7 – 63)
	Male	87	20	16*	24.13 (11.51)	90	56 (7 – 63)
	Female	10	31.5	14	30.50 (15.35)	10	45 (11 – 56)

*Multiple modes exist. Lowest mode is shown.

Also, of the unemployed offenders, 83 percent were males and 17 percent were females; similarly, of the employed offenders, 90 percent were males, and 10 percent female (Binomial tests $p < .0001$); i.e. the gender ratio was the standard 10 to 20 percent females, and there was no significant difference between the two proportions, $\Phi(355) = .084$ $p = .115$.

There was no support for the hypothesis that male arsonists would be more likely to commit offences while unemployed than females; if anything, the trend was for females to be proportionately more represented in the unemployed category. An ANOVA on the age of first offence data found the usual significant main effect for gender, $F(1,351) = 12.61, p < .001, \eta^2_p = .035$; i.e. overall females were older than males at the time of their first offence. However, no significant main effect for age of first offence was found for offenders in employment as opposed to offenders not in employment, $F(1, 351) = 2.97, p = .086, \eta^2_p = .008$, and the interaction was not significant either, $F(1, 351) = .663, p = .416, \eta^2_p = .002$.

With regards to those in employment; the only category of employment occurring with any frequency was *manual labour*; in fact, of the sample of 355, 52(17 percent) were recorded as being manual workers, of which 54 (18 percent) were females and 301 (82 percent) males. As expected, this ‘standard’ gender ratio was highly significant (Binomial test, $p < .0001$); however, the proportions of males and females (90 percent and 10 percent, and 82 percent and 18 percent, for manual workers and those not engaged in manual work, respectively) did not differ between those classified as manual labourers and those not ($\Phi = < .002, p > .20$). A 2 x 2 gender x manual/non-manual ANOVA on the age at first offence data showed the usual effect of gender: females, $M = 28.78 (SD = 17.67)$, were significantly older than males, $M = 19.93 (SD = 11.61)$; $F(1,351) = 10.93, p = .001, \eta^2_p = .03$. Further; manual workers, $M = 26.67 (SD = 10.22)$, were significantly older than those not recorded as being in manual work, $M = 19.93 (SD = 13.31)$; $F(1,351) = 6.46, p = .001, \eta^2_p = .03$.

7.3.5. Nationality

The results for nationality according to age at first offence and gender are summarised in Table 7.7. The large majority of offenders (86 percent) were of Danish nationality; the remainder (14 percent) were distributed across a large range of countries including; Turkey,

Iraq, Poland, Afghanistan, Iran, Poland, UK, Iceland, Sweden, Germany, Morocco, Somalia, Lebanon, Chile, Yugoslavia, India, and France (Binomial Test, $p < .0001$). As the numbers for each of the other countries were so small, they were categorised together as ‘non-Danish’. Within both categories, the overwhelming majority of offenders were males; i.e. 84 percent and 92 percent for the Danish and non-Danish categories, respectively (Binomial Tests, $p < .0001$). The proportions of males and females within the two categories (84-16 percent and 92-8 percent) did not differ significantly, $\Phi(355) = .084$, $p = .113$.

Table 7.7: Descriptive Statistics for Nationality by Gender

		<i>N</i>	Median	Mode	Mean (<i>SD</i>)	Percentage	Range
Danish	Total	304	15.5	14	21.63 (13.36)	86	61 (6 – 67)
	Male	254	15	14	20.24 (11.87)	84	57 (6 – 63)
	Female	50	21	14	28.64 (17.79)	16	59 (8 – 67)
Not Danish	Total	51	14	13	19.18 (11.17)	14	43 (8 – 51)
	Male	47	14	13	18.21 (10.07)	92	38 (8 – 46)
	Female	4	29	13*	30.50 (18.43)	8	38 (13 – 51)

*Multiple modes exist. Lowest mode is shown.

An ANOVA on the age data by gender and nationality found the usual significant main effect for gender, $F(1,351) = 8.95$, $p = .003$, $\eta^2_p = .025$; i.e. overall females were older at the time of their first offence than males. However, no significant main effect was found for the age of the offenders and nationality, $F(1,351) = 0.001$, $p = .980$, $\eta^2_p = .0001$, and the interaction was not significant either, $F(1,351) = 0.317$, $p = .574$, $\eta^2_p = .001$.

7.3.6. Ethnicity

Although ethnicity has been referred to on numerous occasions in the literature on arson, and on criminality generally, there appears to be little consistency in terms of definition; in fact, very often none is given. Consequently, here ethnicity was defined in terms of the British

Police Identity Codes (Bowsher, 2007). Again, given the small numbers involved, the data on ethnicity were split broadly into two categories, White and non-White.

Results are shown in Table 7.8. As predicted, the overwhelming majority of offenders (89 percent) were White (Binomial test, $p < .0001$). Moreover, males dominated in both categories; thus, of the White offenders, 83 percent were male and 17 percent female, and, of the non-White offenders, 98 percent were male and 2 percent were female (Binomial tests, $p < .0001$). However, there were proportionately fewer females in the non-White category; in fact, there was only one non-White female in the sample, $\Phi(355) = -.126$ $p = .017$.

Table 7.8: Descriptive Statistics for Ethnicity by Gender

		<i>N</i>	Median	Mode	Mean (<i>SD</i>)	Percentage	Range
White	Total	315	16	14	21.86 (13.43)	89	61 (6 – 67)
	Male	262	15	14	20.40 (11.91)	83	57 (6 – 63)
	Female	53	22	14	29.08 (17.70)	17	59 (8 – 67)
Non-White	Total	40	13	13	16.65 (8.77)	11	37 (8 – 45)
	Male	39	13	13	16.74 (8.86)	98	37 (8 – 45)
	Female	1	13	13	13.00 (-)	2	13 (-)

A 2 x 2 between subjects ANOVA could not be performed on the age data because one of the cell frequencies for gender was zero and had no variance. However, a Welch t test on the data for ethnicity showed that White offenders were significantly older at the time of their first offence than non-White offenders, $t(64) = 3.30$, $p = .002$.

7.3.7. Solo and Group/Co-Offending

Offenders were coded as solo offenders if all of their arson records indicated that they had acted alone, whereas offenders were coded as group offenders if any of their records indicated that they had acted with others. From the records available, there appeared to be no clear evidence of any individual committing acts both alone and with others; i.e. the categories appeared to be discrete.

The results for solo and co-offending in relation to gender and age (at first offence) are shown in Table 7.9. Of the 355 offenders, 56 percent offended in a group and 44 percent offended alone. The difference was significant; i.e. more offenders set fires in a group (Binomial test, $p = .026$). Of the group offenders, 89 percent were males and 11 percent were female offenders, and of the solo offenders 79 percent were males, and 21 percent females. Therefore, in both groups there were significantly more males than females (Binomial tests $p < .0001$); however, proportionately females were represented more in the solo sample, $\Phi(355) = .131$ $p = .014$.

Table 7.9: Descriptive Statistics for Solo/Group offending by Gender

		<i>N</i>	Median	Mode	Mean (SD)	Percentage	Range
Group Offenders	Total	199	14	14	15.60 (7.71)	56	57 (6 – 63)
	Male	176	14	14	15.62 (7.84)	89	57 (6 – 63)
	Female	22	14	14	15.50 (6.65)	11	34 (8 – 42)
Solo Offenders	Total	156	25.5	14	28.51 (14.87)	44	60 (7 – 67)
	Male	124	23	14	26.08 (13.27)	79	56 (7 – 63)
	Female	32	40.5	41	37.91 (17.10)	21	56 (11 – 67)

A 2 x 2 between subjects ANOVA on the age at first offence data found the usual significant main effect for gender, $F(1,351) = 12.53$, $p < .001$, $\eta^2_p = .034$; i.e. overall females were older than males. However, there was also a significant effect for solo/group, $F(1,351) = 98.73$, $p < .001$, $\eta^2_p = .220$; solo offenders were significantly older than those offending in groups; thus supporting the hypothesis that group offenders would be younger than solo offenders when committing their first offence. The interaction was also significant, $F(1,351) = 13.03$, $p < .001$, $\eta^2_p = .036$. Post hoc Welch t tests ($p < .01$) showed that female solo offenders were considerably older at the time of their first offence than all other groups; male

solo offenders were significantly older than both the male and female group offenders, who did not differ significantly from each other.

7.3.8. Targeted Hypothesis: Group/Solo Offenders.

An additional analysis was conducted to test the other hypotheses regarding solo offenders: i.e. arsonists operating as a group will have a history of disruptive behaviour and have adjustment issues, whilst solo offenders will be more likely to have a psychiatric history and will not have been enrolled in school. However, frequency analyses showed that solo offenders tended to fall proportionately more into indicators of all of these categories; i.e. solo offenders were more likely to have a history of serial offences both including arson, $\Phi(355) = -.151, p = .004$, and not including arson $\Phi(355) = -.174, p = .001$, as well as having more trouble at school $\Phi(355) = -.214, p < .0001$, and a having greater likelihood of a psychiatric history $\Phi(355) = -.427, p < .0001$.

7.3.9. Relationships between other Variables

This next section looks at the remaining interrelationships between the variables in both Studies 1 and 2, excluding age and gender. To rationalise the analysis and presentation of results, only the main demographic and biographical classifications were used in this analysis. The particular variables considered, therefore, were: 1) previous history of arson offences (as detailed earlier. this is effectively the single versus serial arson variable considered in Study 1, but with extra cases due to access to more detailed information from the Police regarding pre 2002 offences); 2) Previous Convictions (general); 3) previous convictions other than arson; 4) Rural/Urban Location; 5) Psychiatric History; 6) Employment; 7) Living with parents; 8) School Enrolment; 9) Trouble at School; 10) Nationality; and 11) Ethnicity. The matrix of the Phi coefficients for these variables is presented in Table 7.10. For reasons of space, the related 2 x 2 frequency tables are not

presented here, but are available from the researcher on request. The following relationships were all statistically significant.

Table 7.10: Phi Coefficient Matrix for Demographic and Biographical Characteristics (p values in brackets), n = 355 in all cases

	All Convictions	Convict Excluding Arson	Ethnicity	Nationality	Urban/Rural	Living with Parents	Enrolled at School	Trouble at School	Unemployed	Psych History
Previous Arson offences	.621 (.0001)	.386 (.0001)	-.015 (.785)	-.083 (.120)	.064 (.230)	-.275 (.0001)	-.346 (.0001)	.137 (.010)	-.122 (.022)	.222 (.0001)
All Convictions Excluding Arson			-.089 (.093)	-.116 (.029)	-.053 (.321)	-.273 (.0001)	-.283 (.0001)	.189 (.0001)	-.126 (.017)	.155 (.003)
Ethnicity				.870 (.0001)	-.073 (.171)	-.155 (.003)	-.104 (.050)	.115 (.031)	-.039 (.469)	-.105 (.048)
Nationality					-.059 (.267)	-.083 (.117)	-.044 (.413)	.091 (.085)	-.017 (.752)	.045 (.394)
Rural/Urban Location						.219 (.0001)	.106 (.045)	-.020 (.705)	-.028 (.504)	-.202 (.0001)
Living with Parents							.720 (.0001)	-.102 (.054)	.203 (.0001)	-.554 (.0001)
Enrolled at School								-.093 (.079)	.303 (.0001)	-.475 (.0001)
Trouble at School									-.006 (.906)	.165 (.002)
Unemployed										-.006 (.906)

Previously convicted for arson: not surprisingly there were significant positive relationships between previously being convicted for arson and having a prior conviction of any kind, including arson, as the categories were not mutually exclusive. However, offenders who had previous convictions for arson (serial arsonists) were also more likely to have convictions for other offences excluding arson, be less likely to be living with parents, less likely to be enrolled in school, more likely to have a history of trouble at school, more likely to be employed, and more likely to have a psychiatric history.

All previous convictions: in addition to the above, offenders who had previous convictions for offences including arson were also less likely to be living with parents, were

not enrolled in school, were more likely to have a history of trouble in school, and more likely to be employed, and have a psychiatric history.

Convictions excluding arson: offenders who were convicted for other crimes excluding arson were more likely to be non-White, employed, not living with parents, not enrolled in school, have a history of trouble at school, and have a psychiatric history.

Ethnicity: Not surprisingly, offenders who were Danish tended to be White, but also White offenders were less likely to be living with parents and less likely to have a psychiatric history, but more likely to have a history of trouble at school.

Rural/Urban Location: urban offenders were more likely than rural offenders to be living with their parents and to be enrolled in school, and were less likely to have a psychiatric history.

Living with parents: Again, not surprisingly, offenders who were living with their parents were more likely to be enrolled in school and less likely to be employed. Offenders living with parents were also less likely to have a history of trouble in school, and less likely to have a psychiatric history.

Enrolled at school: In addition to the above, again, not surprisingly, offenders who were enrolled at school were less likely to be employed; but also, offenders who were enrolled in school were also less likely to have a psychiatric history.

Trouble at school: as well as the other relationships already mentioned involving trouble at school, offenders who had a history of trouble at school were more likely to have a psychiatric history.

7.4. Discussion and Conclusion

The main findings regarding these further demographic and biographical characteristics were as follows. Starting with Psychiatric History, contrary to some proposals in the literature only

a minority of these arson offenders (22 percent) had a history of psychiatric diagnosis and/or treatment. However, the proportion of females who had a psychiatric history was significantly higher than for males; females were particularly overrepresented in the categories of depression and suicide. This fits with other findings indicating that females are more represented among mentally ill firesetters (Dickens et al., 2014). Furthermore, offenders with a psychiatric history tended to be older at the time of their first offence than those without, but this was especially the case for females who were found to be significantly older than males for psychiatric history generally, as well as suicide and alcohol abuse issues in particular. Interestingly, rural offenders were also more likely to have a psychiatric history than urban offenders, which goes against the prevailing view that pressures of living in cities increase the risk of mental health problems (Fitzgerald, Rose & Singh, 2016; Srivastava, 2009). However, the most likely reason for this is that arsonists living in urban areas are also more likely to be living with parents and enrolled in school; factors which tend to be associated with lower rates of mental health issues.

With regard to criminal record, 50 percent of the sample had previous convictions for a variety of offences, but only 28 percent had previous convictions for arson in particular (were serial arsonists). This supports the general finding in Study 1 that most of the sample were single arsonists; though of these, 35 percent had previous convictions for other offences. There was also a general trend for those with previous convictions of all types to be older at the time of their first offence, and this was particularly the case for females. Moreover, serial arsonists, as well as those with previous convictions generally, were more likely to be living away from parents, not enrolled in school and have a history of trouble at school and a history of psychiatric problems (n.b. data for serial arson specifically will be revisited in Study 5). Males dominated again in all subgroups of convictions and all showed the standard range gender ratio, with the exception of assault (where the proportion of females was slightly

higher, but not significantly so). As such, the direction of the latter would seem to endorse Harmon et al.'s (1985) finding that female arsonists commonly have convictions for assault rather than arson. Although, as predicted, the majority of arsonists (73 percent) had a record of being unemployed while offending, offenders with previous convictions for arson and other offences were more likely to be employed, which, as hypothesised, fits with previous research indicating that serial arsonists are more likely to be in employment (Sapp, Hobart et al., 1994).

In line with the above, the majority of the offenders had been at school and living with parents at the time of their offence or offences, which is consistent with the general finding that most arsonists tend to be younger adolescents (see for example, Burton et al., 2012; Sapp, Hobert et al., 1994; Snyder, 1999). Further; those living with parents and enrolled at school tended to be younger at the time of their first offence than those not living with parents or enrolled in school. However, not all arsonists living with parents were young at the time of their first offence; the oldest was, in fact, 50. In light of other findings the latter finding makes sense, as these categories will tend to be dominated by young single (as opposed to serial offenders) who tend to commit their 'one-off' offences (motivated by boredom, 'fun-seeking' etc.) at an earlier age than serial offenders, who may come from more dysfunctional backgrounds and have adjustment issues that result (or resulted) in them living apart from their parents. In the same way, those living, or who had lived, in an institution, had trouble at school, and had been recently divorced prior to offending, were also older at the time of their first offence. Notably, females were overrepresented in both categories of living in an institution and recently divorced; again suggesting that they may be reacting against a dysfunctional home background (Steketee et al., 2013).

Non-White offenders were also more likely to be living with parents. Also, urban offenders were more likely to be living with their parents, as well being enrolled at school

while offending, which is in line with view that offenders in urban areas tend to be younger (Perryman, 2016). One possible reason for this might simply be that small towns do not offer the same educational opportunities as bigger cities, hence young people often move to the bigger cities, where higher level education is available to them. Moreover, people already living in the cities live longer with their parents simply because it is more expensive to live in the city (Rugg & Quilgars, 2015). Also, as mentioned above, it was found that offenders not living with parents at the time of their offences were more likely to have a history of trouble at school and a psychiatric history, which could be caused in part by these still young offenders being influenced by and placed outside of a dysfunctional home. As predicted, the majority of the offenders were Danish and White; the gender ratios between the two subgroups did not differ significantly from each other, though there was only one female in the non-White subgroup. Contrary to some media speculation, there was clearly no evidence that non-Whites or those of non-Danish nationality were overrepresented in the sample. It is perhaps worth noting here that, although socio-economic status was not measured in the present sample, within the Western societies the majority of arsonists are from lower social income groups (i.e. Bennett et al., 1987; Federal Emergency Management Agency, 1997). As such, any possible motives based on perceived powerlessness or disadvantage that arsonists may have may be as keenly felt by both majority White offenders as minority groups (see, for example, Kjeldberg, 1996; Lindholm, Mikkelsen et al., 2000). However, non-Whites tended to younger and more likely to have a criminal and a psychiatric history, presenting the possibility that they may have a tendency for different motives; for example, White offenders might be more tempted to offend out of boredom or frustration than other ethnic groupings, a possibility that might be worth following up in future research. Finally, with regard to solo versus group offending, as predicted, significantly more offenders operated in groups. However, solo operators tended to be older at the time of their first offence, and more females

were represented in the solo sample. Moreover, female solo offenders were found to be significantly older than male solo offenders, as well as male and female group offenders. Also, solo offenders were more likely to have a psychiatric history, indicating perhaps the more individualistic personal motivations behind their offences.

7.4.1. Summary Findings: Categorising Arson

If we take the various results together, notwithstanding considerable overlap between categories, arguably what seems to be emerging is a possible distinction between three categories of arsonist, 1) the more frequent opportunistic arsonist, predominantly male, mainly young, at school or unemployed, often living with parents, and often offending in groups; 2) a less frequent, but more serious, often more persistent serial offender, who is more likely to be older at the time of their first offence, employed, have a history of disruptive behaviour and mental health issues, and operate alone, and 3) a category of mainly female offenders who are less likely to be serial offenders, but who are also older at the time of their first offence than those in first category, have mental health issues, particularly tendencies to depression and suicide, operate alone, and are more likely than those in the other categories to have been living in an institution, and/or divorced.

Chapter 8

Study 3 – Offence Related Behaviours and Characteristics of Arsonists

8.1. Introduction

In this chapter we turn to behaviours and characteristics associated with the actual offences themselves. From the police records for the $n = 355$ subset, it was possible to code offenders on a number of offence related behaviours and crime scene variables, some of which have been identified in the literature on arson.

The first group of variables related to the *targets chosen by offenders*. These were Residential, Business, School, Public Building, Vehicle, Miscellaneous, Self, and Own Home.

The second group involved *the relationship between the offender and any victims*. These were whether the victim was known to the offender (generally), was an ex-partner, prior violence was used to victims, there were threats to the victim, and whether lives were endangered deliberately.

The third group involved *crime scene behaviours*. These were, whether the offence was planned, whether the offender acted alone or in a group, whether the offender used multiple fire sites and/or fired multiple items, whether accelerants and/or other materials were brought to the scene, whether the offender gave an alert, whether the offender remained at the scene, whether there was alcohol use at the time of the offence, and travel distances.

As noted in the previous chapter, solo versus group offending has already been considered in terms of its possible demographic and biographical characteristics, but it is

considered again here specifically as an offence related characteristic to assess its relationship with other offence related behaviours.

8.2. Research Questions

In the previous studies, the primary emphasis was on describing the demographic and biographical characteristics of offenders, particularly in terms of age (of first offence) and gender; and the statistical approach reflected this (frequency analyses, ANOVAs etc.). Thus, in the previous studies, following the literature, the main research question form was essentially descriptive; i.e. ‘How does the sample split in terms of age, gender, serial versus single offending etc.?’ However, in the next two studies, a different approach was adopted, centring more on the variables that best predict whether these particular characteristics will be involved in an offence or set of offences; in other words, the research questions were more investigative. Thus, in Study 3, presented in this chapter, the research question concerned ‘to what extent can particular offence related behaviours and characteristics be predicted from other offence related behaviours and characteristics’, and in Study 4, presented in the next chapter, the questions were, ‘which demographic and biographical characteristics best predict whether offenders will show a particular offence related behaviour?’ Or put another way, ‘what kind of offender most is at risk for engaging in a certain type of offence related behaviour?’ To answer these latter questions the statistical approach for summarising data is the use of a series of Binary Logistic Regressions, as explained in Chapter 5. Furthermore, AUC statistics (area under the ROC curve) were generated to measure the overall predictive accuracy and odds ratio was used as effect size (see Chapter 5).

To avoid unnecessary duplication of analyses, the variables selected as dependent variables were those considered most useful as a ‘starting point’ for forensic investigators: i.e. *targets chosen by offenders* (Residential, Business, School, Public Building, Vehicle,

Miscellaneous, Self, and Own Home), and *crime scene behaviours* (whether the offence was planned, whether the offender acted alone or in a group, whether the offender used multiple fire sites and whether multiple items were fired, whether accelerants and/or other materials were brought to the scene, whether the offender gave an alert, whether the offender remained at the scene, whether the offender was under the influence of alcohol, and travel distances).

8.3. Coding and Definitions of Offence Related Behaviours

All variables were binary coded except for travel distances, where the mean travel distance for each offender was used as a predictor; however, for reasons given shortly, when used as a dependent variable, travel distance too was coded in binary form. Consequently, when there were multiple offences, and the variable was binary, offenders were coded according to whether none of their offences occurred in a particular category, or whether at least one of their offences fell in the specified category (as in Goodwill et al., 2009). So, for example, offenders were coded as not using accelerants if none of their offence involved accelerants, and using accelerants if at least one of their offences involved the use of accelerants. The definitions of the 22 offence related behavioural variables were as follows.

Residential: A residential property refers to a property which at the time of the fire was being used for residential purposes. This could be a one family house, villa, bungalow, flat etc.

Business: A property would be coded as a business if it was currently in use as business premises, irrespective of location or size.

School: Any educational establishment was coded as a school. Accordingly, any fire started in on school property, such as in a waste bin, would be coded as school. However, if the fire was started in waste bins near but outside school property it would be coded as miscellaneous.

Public Building: A building was coded as a public building if it was a building to which the public have access; such as, library, church, town hall, law courts, police station, hospital, etc. Schools were not included in this category.

Vehicle: Any means of transportation for goods or people was coded as a vehicle, including, cars, motorbikes, bicycles and boats.

Miscellaneous: Any item which were not inside a building property or on the grounds of building property ground, for example, a rubbish bin or park bench, was be coded as miscellaneous.

Self: An event was coded as 'self' if an individual set a fire to their own home, and made no attempt to leave.

Own Home: Own home was coded as present if the offender set fire to their own home and but then left; i.e. the purpose was not to endanger their own life.

Multiple items and Multiple Sites: The next two variables, multiple items and multiple sites were derived directly from Fritzon's (1998) analysis of arson offenders, and, according to Fritzon, represent two types of modus operandi for offenders. The first, multiple items, refers to offenders who set light to multiple specific objects, such as a chair and a sofa, or some bins, which may or may not be in the same site (for example, they may be in the same or in different rooms). Hence those who did or did not do this would be coded accordingly on this variable. The second, multiple sites, refers to offenders who appear to specifically target multiple sites, rather than specific objects or items. So, for example, they may fire accelerant materials on the floors of two or three different rooms. Again those who did or did not do this were coded accordingly. However, the two categories are not mutually exclusive; an offender may target different sites, and also multiple items across and within sites. Indeed, in the present data set, the two were related ($\Phi = .39, p < .001$), though not sufficiently to raise a collinearity issue.

Group/Solo: As before, offenders were coded as group offenders if they at any point had acted with others, and solo offenders if all of their arson records indicated that they had acted alone.

Planned: An offence was coded as planned if materials were used which required thinking ahead, such as acquiring petrol or other fireable fluids as accelerants, and/or making an effort to avoid detection by, for example, wearing gloves when handling petrol containers.

Accelerant (planned and unplanned): Accelerant was coded as present if any type of accelerant was used, such as petrol, lighter fuel, propane, wood, cardboard or other items which might speed up the process of the fire.

Material Brought; Material brought refers to use of readily available, every day, items acquired and used to aid the offence, that would require little if any planning. Thus, material brought would include items such as cigarettes, candles, cloth etc., as well as items easily acquired en route to, or nearby, the crime scene and then used as ‘unplanned’ accelerants, such as dry branches, cardboard, and wood pallets. Material Brought items would thereby, be considered distinct from more specialist items that will more likely have been specifically acquired in advance to start and accelerate the fire (such as, petrol, propane etc.).

Alert: Alert was coded as present if the offender left the crime scene to alert the fire brigade or any other person after or during the fire.

Remain/Returned: Remain/Returned was coded as present if the offender remained at the scene, or returned while the fire was still burning.

Victim Known: Victim known was coded as present if the offender knew the victim in any way. This could be private through relations, such as friends and family, but also people representing institutions or governing bodies that the offender had been involved with, such as a school, social services, counsels, landlord, etc.

Victim Ex-Partner: Victim ex-partner would be coded as present if the property fired belonged to the ex-partner of the victim or someone close to the ex-partner of the victim, such that the deed was clearly aimed at the ex-partner; i.e. the person would not have been targeted were it not for their association with the ex-partner.

Prior Violence Towards Victim: Prior violence towards victim was coded as present if there was any prior record of a violent dispute with the victim, or evidence of self-harm if the arson was self-directed.

Prior Threats Towards Victim: Prior threats towards the victim were coded as present if there were any records of prior verbal or physical threats towards the victim.

Lives Endangered Deliberately: Lives endangered deliberately was coded as present if appeared clear that the fire was aimed to deliberately harm someone.

Alcohol: Alcohol was coded as present if offender admitted to having consumed alcohol before and/or during the offence, or if the police or a witness stated that the offender appeared to be drunk or smelled of alcohol before or after the offence.

Travel Distance: Travel distance referred to the distance the offender travelled from their home location to crime scene.

For a summary of the codings of variables used in this chapter see Appendix 5.

8.4. Hypotheses

Although the main approach in this chapter was exploratory, some main hypotheses derived from the relevant literature (summarised in Chapter 4) were as follows (hypotheses regarding demographic correlates of offence related behaviour are described in the next chapter).

1. In terms of offence related behavioural characteristics, the majority of the offenders will use an accelerant and offend under the influence of alcohol. However, solo offenders will

be more likely use an accelerant, bring fire lighting materials with them, offend under the influence of alcohol and be more likely to know their victims.

2. The majority of offenders will not travel far from their home location to commit their offences; i.e. 0 – 5 km.

8.5. Results: Targets

The first group of analyses concerns the targets of the offences. Because the majority of offenders were single (one-time) offenders (72%) as opposed to serial offenders (18%), it was not possible to use targets to predict other targets as classification in one category would, for most of the sample, automatically preclude classification in the others, making interpretation meaningless. So, in the regressions in this section which specify targets as the dependent variables, the other targets are not included as predictors.

Nevertheless, first it may be informative to examine the relationships between target sources for serial arson offenders (i.e. those who have a record of multiple offences/targets and thus classification in one category does not preclude classification in others).

Table 8.1: Phi Coefficients between Arson Targets for serial Offenders (n = 100)

	Busin	School	Public Blg	Vehicle	Misc	Self	Own Home
Residential	-.248*	-.346**	-.314**	-.322**	-.221*	.281**	.418**
Business		-.190	-.173	-.230*	-.069	-.109	-.173
School			.589**	.389**	-.148	-.152	-.242*
Public Blg				.461**	-.197*	-.042	-.152
Vehicle					-.262**	-.184	-.292**
Miscellaneous						-.124	-.197*
Self							.629**

* Correlation is significant at < .05 (2-tailed).

** Correlation is significant at <.01 level (2-tailed).

Table 8.1, therefore, shows the matrix of Phi coefficients between the various targets for serial offenders. An examination of Table 8.1 indicates some apparent patterns. Not unexpectedly, those who targeted residential properties were significantly more likely to target themselves and their own homes, and less likely to choose other targets. However, in contrast, those who targeted schools were significantly more likely to target public buildings, and vehicles, but less likely to target their own homes. Those who targeted businesses were less likely to target vehicles, but otherwise targeting of businesses was relatively discrete and showed non-significant negative trends as regards other targets. And, finally, those who targeted miscellaneous objects tended to be less likely to target residential buildings, public buildings and vehicles.

The breakdown of the binary logistic regression findings for each offence based target variable for the full sample ($n = 355$) was as follows.

8.5.1. Residential

The number of offenders who targeted a residential property was 107 (30%), whereas the majority, 248 (70%), targeted non-residential targets (Binomial test $p < .0001$).

Table 8.2: Binary Logistic Regression with Residential Target as Dependent variable and Offence related Behaviours as Predictors

	<i>B</i>	<i>SE</i>	Wald	<i>df</i>	<i>p</i>	Exp(B)
Lives Endangered	1.82	0.37	24.32	1	.0001	6.16
Alert After Fire	1.08	0.36	8.80	1	.003	3.00
Multiple Sites	1.17	0.43	7.60	1	.006	3.23
Victim Ex-Partner	2.13	0.80	7.05	1	.008	8.43
Group/Solo	-.83	0.36	5.30	1	.021	0.44

A binary logistic regression with Residential Target as the dependent variable and the other offence related behavioural characteristics as the predictors (see Table 8.2) significantly predicted 84% of cases, $\chi^2 (15) = 159.66, p < .0001$, and explained 51% of the variance (Nagelkerkel $R^2 = .51$). Significant predictors of targeting residential properties were: targeting ex-partner ($p = .008$), deliberately endangering lives ($p < .0001$), being a solo offender ($p = .021$), using multiple fire sites ($p = .006$), and giving an alert during or after the fire ($p = .003$). An ROC analysis showed an AUC value of .87 ($SE = .02; p < .0001$).

8.5.2. Business

The number of offenders who targeted a business property was 37 (10%), whereas the majority, 318 (90%), targeted non-business properties (Binomial test $p < .0001$).

The same regression with Business Target as the dependent variable and the other offence related behavioural characteristics as the predictors was not significant, $\chi^2 (15) = 17.46 p = .292$ and explained only 10% of the variance (Nagelkerkel $R^2 = .098$).

Correspondingly, none of the predictors was significant.

8.5.3. School

The number of offenders who targeted a school property was 62 (18%), whereas the majority, 293 (82%), did not target a school (Binomial test $p < .0001$).

The regression with School Target as the dependent variable and the other offence related behavioural characteristics as the predictors (see Table 8.3) significantly predicted 87% of cases, $\chi^2 (15) = 92.077, p < .0001$, and explained 38% of the variance (Nagelkerkel $R^2 = .38$). Significant predictors of targeting a school property were: not planning firesetting ($p = .007$), not endangering lives deliberately ($p = .028$), not remaining at or returning to the crime location ($p = .002$), and not being under the influence of alcohol during the firesetting ($p =$

.009); but firing multiple items ($p = .005$) and bringing material to the crime location ($p = .027$). The AUC value was .84 ($SE = .03$), $p < .0001$).

Table 8.3: Binary Logistic Regression with School Target as Dependent variable and Offence related Behaviours as Predictors.

	<i>B</i>	<i>SE</i>	Wald	<i>df</i>	<i>p</i>	Exp(B)
Remained/Returned	-1.93	0.62	9.77	1	.002	0.15
Multi Items Fired	1.39	0.50	7.72	1	.005	4.01
Planned	-1.15	0.43	7.19	1	.007	0.32
Material Brought	1.01	0.46	4.87	1	.027	2.74
Lives Endangered	-1.16	0.53	4.80	1	.028	0.32
Alcohol Use	-.93	0.47	3.97	1	.046	0.39

8.5.4. Public Building

The number of offenders who targeted a public building was 54 (15%), whereas the majority, 301 (85%), did not target a public building (Binomial test $p < .0001$).

Table 8.4: Binary Logistic Regression with Public Building as Dependent variable and, Offence related Behaviours as Predictors.

	<i>B</i>	<i>SE</i>	Wald	<i>df</i>	<i>p</i>	Exp(B)
Multiple Items Fired	1.64	0.49	11.08	1	.001	5.15
Alert After Fire	-2.57	0.81	10.10	1	.001	0.08
Alcohol Use	-1.70	0.59	8.41	1	.004	0.18
Group/Solo	1.08	0.50	4.68	1	.031	2.94

The regression with Public Building as the dependent variable and the other offence related behavioural characteristics as the predictors (see Table 8.4) significantly predicted 87% of cases, $\chi^2 (15) = 82.48$, $p < .0001$, and explained 36% of the variance (Nagelkerkel $R^2 = .36$). Significant predictors of targeting a public building were: not being under the influence of alcohol ($p = .004$), not giving an alert ($p < .001$); but firing multiple items ($p = .001$), and operating as a group ($p = .031$). The AUC value was .69 ($SE = .041$), $p < .0001$).

8.5.5. Vehicle

The number of offenders who targeted a vehicle was 60 (17%), whereas 295 (83%) did not target a vehicle (Binomial test $p < .0001$).

The regression with Vehicle as the dependent variable and the other offence related behavioural characteristics as the predictors (see Table 8.5) significantly predicted 88% of cases, $\chi^2(15) = 147.56, p < .0001$, and explained 57% of the variance (Nagelkerke $R^2 = .57$). Significant predictors of targeting a vehicle were: not knowing the victim(s) ($p < .0001$, not endangering lives ($p < .0001$) and not giving an alert during or after the fire ($p = .001$); but bringing materials ($p = .037$), using an accelerant ($p = .001$), and being under the influence of alcohol at the time of the crime ($p < .0001$). The AUC value was exceptional at .92 ($SE = .019$), $p < .0001$.

Table 8.5: Binary Logistic Regression with Vehicle as Dependent variable and Offence related Behaviours as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(B)
Victim Known	-3.44	0.69	24.74	1	.0001	0.03
Lives Endangered	-2.74	0.78	12.48	1	.0001	0.06
Alcohol Use	2.28	0.49	21.55	1	.0001	9.74
Accelerant Used	1.65	0.50	10.96	1	.001	5.21
Alert After Fire	-2.64	0.81	10.59	1	.001	0.07
Prior Violence to Victim	2.37	0.81	8.60	1	.003	10.75
Material Brought	1.07	0.52	4.34	1	.037	2.92

8.5.6. Miscellaneous

The number of offenders who targeted Miscellaneous object/s was 82 (23%), whereas the majority, 273 (77%), did not (Binomial test $p < .0001$).

The regression with Miscellaneous as the dependent variable and the other offence related behavioural characteristics as the predictors (see Table 8.6) significantly predicted

82% of cases, $\chi^2 (15) = 86.71, p < .0001$, and explained 33% of the variance (Nagelkerke $R^2 = .33$).

Table 8.6: Binary Logistic Regression with Miscellaneous Object/s as Dependent variable and Offence related Behaviours as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(B)
Multiple Sites Fired	-1.79	0.59	9.30	1	.002	0.17
Lives Endangered	-1.31	0.45	8.51	1	.004	0.27
Accelerant Used	-0.10	0.37	7.45	1	.006	0.37
Alert After Fire	0.90	0.33	7.21	1	.007	2.47
Multiple Items Fired	1.35	0.52	6.61	1	.010	3.85

Significant predictors of targeting miscellaneous objects were: not endangering lives ($p < .004$), not firing multiple sites ($p < .002$), and not using an accelerant ($p < .006$); but firing multiple items ($p = .003$) and giving an alert during or after the fire ($p = .007$). The AUC value was .82 ($SE = .028$), $p < .0001$).

8.5.7. Self

The number of offenders who targeted themselves was 22 (6%), whereas the majority, 333 (94%), did not target themselves (Binomial test $p < .0001$).

Table 8.7: Binary Logistic Regression with Self as Dependent variables, Offence related Behaviours as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(B)
Multiple Sites Fired	1.54	0.66	5.40	1	.020	4.68
Prior Violence to Victim	1.33	0.63	4.43	1	.035	3.76
Accelerant Used	-1.82	0.90	4.14	1	.042	0.16

The regression with Self as the dependent variable and the other offence related behavioural characteristics as the predictors (see Table 8.7) significantly predicted 95% of

cases, $\chi^2(12) = 66.12, p < .0001$, and explained 46% of the variance (Nagelkerke $R^2 = .46$). Given the nature of the act/s, ‘victim known’, ‘remained/returned’, and ‘endanger lives’ were excluded as predictors in this analysis, as all applied to the dependent variable by definition. Three significant predictors emerged of self-targeting; these were: showing prior violence to victim (meaning previously harm themselves and/or others; $p = .035$), firing multiple sites ($p < .020$), and not using an accelerant ($p = .042$). The AUC value was outstanding at .92 ($SE = .020$), $p < .0001$).

8.5.8. Own Home

The number of offenders who targeted own home was 59 (17%), whereas the majority, 296 (83%), did not (Binomial test $p < .0001$).

Table 8.8: Binary Logistic Regression with Target Own Home as Dependent variable and Offence related Behaviours as Predictors.

	<i>B</i>	<i>S.E.</i>	Wald	df	<i>p</i>	Exp(B)
Lives Endangered	2.14	0.420	25.85	1	.0001	8.46
Group/Solo	-1.22	0.446	7.54	1	.006	0.29
Alert After Fire	0.74	0.390	3.59	1	.058	2.09

The regression with Target Own Home as the dependent variable and the other offence related behavioural characteristics as the predictors (see Table 8.8) significantly predicted 85% of cases, $\chi^2(13) = 95.62, p < .0001$, and explained 40% of the variance (Nagelkerke $R^2 = .40$). Because of categorical/coding overlap, ‘Victim known’ was excluded as a predictor in this analysis, as well as ‘remained/returned’. Significant predictors of targeting own home were: endanger lives deliberately ($p < .0001$), and acting alone ($p = .006$); though giving an alert was also nearly significant ($p = .058$). The AUC value was .86 ($SE = .026$), $p < .0001$).

8.6. Results: Crime Scene Variables

The next group of analyses concerns the crime scene behaviours. For these, unless otherwise stated, all variables were entered in the analyses.

8.6.1. Planned

The number of offenders who planned their offence/s was 144 (41%), whereas the majority, 211 (59%), did not plan their offence/s (Binomial test $p = .0004$).

The regression with Planned as the dependent variable and the other offence related behavioural characteristics as the predictors (see Table 8.9) significantly predicted 76% of cases, $\chi^2(21) = 129.70, p < .0001$, and explained 41% of the variance (Nagelkerke $R^2 = .41$). It can be noted that, because the use of certain kinds of accelerants was coded as evidence of ‘planned’ arson (such as petrol, or other flammable liquids), ‘accelerant’ was not included in this regression as a predictor (not surprisingly, if included, the latter significantly predicted the former).

Table 8.9: Binary Logistic Regression with Arson Planned as Dependent variable and Offence related Behaviours as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(B)
Material Brought	2.16	0.32	46.92	1	.0001	8.66
Target School	-1.44	0.44	10.49	1	.001	0.24
Victim Known	1.26	0.36	12.11	1	.001	3.52
Target Misc.	-1.00	0.45	5.01	1	.025	0.37
Prior Viol to Victim	0.99	0.48	4.25	1	.039	2.68
Lives Endangered	0.80	0.40	4.00	1	.046	0.45
Target Vehicle	-0.95	0.48	3.93	1	.048	0.39

Significant predictors of planned arson were as follows: not targeting schools ($p = .001$), vehicles ($p = .048$), and miscellaneous targets ($p = .025$); but knowing the victim ($p = .001$), showing prior violence towards the victim ($p = .039$), deliberately endangering lives ($p = .046$).

= .046), and bringing material to the crime scene ($p < .0001$). The AUC value was .83 ($SE = .022$), $p < .0001$).

8.6.2. Group/Solo

As mentioned in Study 2 (Chapter 7), of the 355 offenders, the majority, 199 (56%), offended as a group, whereas 156 (44%) offended on their own (solo); the difference was significant (Binomial test $p = .026$).

Table 8.10: Binary Logistic Regression with Group/Solo as Dependent variable and Offence related Behaviours as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(B)
Prior Violence to Victim	-1.71	0.52	10.96	1	.001	0.18
Prior Threat to Victim	2.50	0.79	10.03	1	.001	12.42
Accelerant Used	0.89	0.35	6.56	1	.013	2.38
Target Residential	-1.18	0.48	6.04	1	.018	0.32
Material Brought	0.70	0.34	4.30	1	.041	2.00

The regression with Group/Solo offending as the dependent variable and the other offence related behavioural characteristics as the predictors (see Table 8.10) significantly predicted 80% of cases, $\chi^2(22) = 167.13$, $p < .0001$, and explained 50% of the variance (Nagelkerke $R^2 = .50$). Significant predictors for setting fires while alone were: targeting residential property ($p = .018$), and using prior violence towards the victim ($p = .001$); but not making prior threats towards the victim ($p = .001$), using accelerants ($p = .013$), or bringing materials to the crime scene ($p = .041$). The AUC value was .87 ($SE = .019$), $p < .0001$).

Interestingly, therefore, the hypothesis that solo offenders would be more likely to use an accelerant was not supported; indeed, the opposite was the case in that using an accelerant was significantly predictive of group offending. Also, there was no support in the regression for the hypothesis that solo offenders would be more likely to know their victim; however,

the zero-order Phi coefficient between the two was significant in the predicted direction, $\Phi = -.22, p < .0001$. To investigate the latter finding in more detail, therefore, the regression was rerun starting with only victim known as the predictor. In line with the zero-order Phi, the result was highly significant ($p < .0001$); however, victim known ceased to be a significant predictor of solo-offending only when previous violence to the victim was entered into the regression. These results suggest that victim known does indeed predict solo-offending when considered by itself, but the main reason this occurs is because offenders tend to direct previous violence towards victims they know, and it is previous violence, rather than knowing the victim per se, that is most predictive of solo offending.

8.6.3. Multiple Fire Sites

The number of offenders set fire to multiple sites was 75 (21%), whereas the majority, 280 (79%), did not (Binomial test $p < .0001$).

Table 8.11: Binary Logistic Regression with Multiple Fire Sites as Dependent variable and Offence related Behaviours as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(<i>B</i>)
Multiple Items Fired	2.54	0.56	20.83	1	.0001	12.64
Target Residential	2.10	0.65	10.44	1	.001	8.26
Lives Endangered	1.35	0.43	9.97	1	.002	3.85
Target School	1.66	0.65	6.52	1	.011	5.24
Prior Violence to Victim	-1.28	0.55	5.33	1	.022	0.28
Target Business	1.51	0.72	4.39	1	.036	4.53

The regression with Multiple Fire Sites as the dependent variable and the other offence related behavioural characteristics as the predictors (see Table 8.11) significantly predicted 86% of cases, $\chi^2(22) = 117.05, p < .0001$, and explained 44% of the variance (Nagelkerke $R^2 = .44$). Significant predictors of using multiple fire sites were: not showing prior violence towards the victim ($p = .022$); but targeting residential ($p = .001$), business ($p =$

.036), and school properties ($p = .011$), endangering lives deliberately ($p = .002$), and firing multiple items ($p < .0001$). The AUC value was .85 ($SE = .026$), $p < .0001$).

8.6.4. Multiple Items Fired

The number of offenders who targeted a Multiple Items Fired was 44 (12%), whereas the majority, 311 (88%), did not set fire to multiple items (Binomial test $p < .0001$).

Table 8.12: Binary Logistic Regression with Multiple Items as Dependent variable and Offence related Behaviours as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(B)
Target Miscellaneous	2.75	0.74	13.93	1	.0001	15.71
Fire Multiple Sites	2.76	0.62	20.05	1	.0001	15.72
Target Public Building	2.89	0.78	13.87	1	.0001	17.94
Target Own Home	2.06	0.87	5.65	1	.017	7.82
Target School	1.41	0.67	4.39	1	.036	4.11

The regression with Multiple Items Fired as the dependent variable and the other offence related behavioural characteristics as the predictors (see Table 8.12) significantly predicted 92% of cases, $\chi^2(22) = 117.08$, $p < .0001$, and explained 53% of the variance (Nagelkerke $R^2 = .53$). Significant predictors of setting fire to multiple items were: enrolled in school ($p = .036$), targeting public buildings ($p < .0001$), miscellaneous items ($p < .0001$), and own home ($p = .017$), and also, firing multiple sites ($p < .0001$). The AUC value was exceptional at .92 ($SE = .018$), $p < .0001$).

8.6.5. Accelerants

The number of offenders who used an accelerant was 164 (46%), whereas 191 (54%) did not use accelerant; the difference was not statistically significant (Binomial test $p > .05$).

The regression with Accelerant as the dependent variable and the other offence related behavioural characteristics as the predictors (see Table 8.13) significantly predicted 76% of

cases, $\chi^2(20) = 123.47, p < .0001$, and explained 39% of the variance (Nagelkerkel $R^2 = .39$). Again, because of the considerable coding overlap between Accelerant as the dependent variable, and Planned and Material Brought, the latter were not included as predictors in this analysis (if included, both predicted accelerant significantly). Significant predictors of using accelerant were: not targeting self ($p = .005$), but targeting businesses ($p = .035$) and vehicles ($p < .0001$), knowing the victim ($p < .0001$), offending in a group ($p = .005$), and firing multiple fire sites ($p = .020$). The AUC value was .82 ($SE = .022$), $p < .0001$. These results again reflect the finding that, contrary to the hypothesis, group offenders were more likely to use accelerants.

Table 8.13: Binary Logistic Regression with Accelerant as Dependent variable and Offence related Behaviours as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(B)
Target Vehicle	2.06	0.47	18.91	1	.0001	7.82
Victim Known	2.15	0.37	33.84	1	.0001	8.62
Target Self	-2.37	0.86	7.71	1	.005	0.09
Group/Solo	0.92	0.33	7.97	1	.005	2.50
Multiple Sites	0.86	0.37	5.48	1	.020	2.37
Target Business	1.10	0.52	4.44	1	.035	3.02

8.6.6. Materials Brought to Crime Scene

The number of offenders who brought material to the crime scene was 176 (50%), whereas 179 (50%) did not bring any material to the crime scene. The difference was not statistically significant (Binomial test, $p > .05$).

The regression with Materials Brought to the crime scene as the dependent variable and the other offence related behavioural characteristics as the predictors (see Table 8.14) significantly predicted 80% of cases, $\chi^2(21) = 161.03, p < .0001$, and explained 49% of the variance (Nagelkerkel $R^2 = .49$). Again, because of the considerable overlap between

materials brought and accelerant used, the latter was excluded as a predictor in this analysis (if included, the latter significantly predicted the former).

Table 8.14: Binary Logistic Regression with Materials Brought as Dependent variable and Offence related Behaviours as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(B)
Planned	2.14	0.32	45.18	1	.0001	8.50
Group/Solo	0.97	0.33	8.96	1	.003	2.64
Target Vehicle	1.40	0.48	8.44	1	.004	4.06
Alcohol Use	-0.94	0.35	7.39	1	.007	0.39
Victim Known	0.87	0.38	5.22	1	.022	2.38
Target Misc.	0.90	0.42	4.64	1	.031	2.46
Target Public Bldg	1.08	0.50	4.59	1	.032	2.93
Target School	0.99	0.47	4.48	1	.034	2.70
Target Self	-2.54	1.23	4.26	1	.039	0.08

Significant predictors of brought materials to the crime scene were: not under the influence of influence of alcohol during the time of the crime ($p = .007$), and not targeting self ($p = .039$); but targeting schools ($p = .034$), public buildings ($p = .032$), vehicles ($p = .004$), and miscellaneous objects ($p = .031$), knowing the victim ($p = .022$), planning the firesetting ($p < .0001$), and offending in a group ($p = .003$). The AUC value was .86 ($SE = .019$), $p < .0001$). Again, therefore, the hypothesis that solo offenders would be more likely to bring materials was not supported; indeed, the opposite was the case in that bringing materials was significantly predictive of group offending.

8.6.7. Alert

The majority of offenders did not give an alert during or after they set fire, 276 (78%), whereas 79 (22%) did (Binomial test $p < .0001$).

The regression with Alert as the dependent variable and the other offence related behavioural characteristics as the predictors (see Table 8.15) significantly predicted 80% of

cases, $\chi^2(22) = 66.13, p < .0001$, and explained 26% of the variance (Nagelkerkel $R^2 = .26$). Significant predictors of gave alert during or after firesetting were: targeting residential property ($p = .006$), and miscellaneous objects ($p = .042$), setting fire to multiple items ($p = .039$), and remaining at or returning to the crime scene ($p = .016$). The AUC value was .78 ($SE = .028$), $p < .0001$).

Table 8.15: Binary Logistic Regression with Alert as Dependent variable and Offence related Behaviours as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(B)
Target Residential	1.41	0.51	7.69	1	.006	4.06
Remained/Returned	0.81	0.34	5.77	1	.016	2.26
Multiple Items Fired	1.02	0.49	4.27	1	.039	2.78
Target Miscellaneous	0.89	0.44	4.15	1	.042	2.44

8.6.8. Remained/Returned to Crime Scene

The number of offenders who remained at or returned to the crime scene was 109 (31%), whereas the majority, 246 (69%), did not remain or return (Binomial test $p < .0001$).

The regression with remained at or returned to the crime scene as the dependent variable and the other offence related behavioural characteristics as the predictors (see Table 8.16) significantly predicted 79% of cases, $\chi^2(21) = 122.52, p < .0001$, and explained 41% of the variance (Nagelkerkel $R^2 = .41$). Because of overlap Target Self was not included in this regression. Significant predictors were: not targeting schools ($p = .011$), but targeting own home ($p = .002$), endangering lives ($p = .001$, and giving an alert during or after firesetting ($p = .018$). The AUC value was .85 ($SE = .022$), $p < .0001$).

Table 8.16: Binary Logistic Regression with Remain/Returned to Scene as Dependent variable and Offence related Behaviours as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(B)
Lives Endangered	1.31	0.38	12.02	1	.001	3.69
Own Home	1.36	0.44	9.41	1	.002	3.88
Target School	-1.64	0.65	6.44	1	.011	0.20
Alert After Fire	0.81	0.34	5.68	1	.017	2.25

8.6.9. Alcohol Used

The number of offenders who were under the influence of alcohol while firesetting was 109 (31%), whereas the majority, 246 (69%), did not (Binomial test $p < .0001$). Thus the hypothesis that the majority of offenders would use alcohol was not supported.

The regression with Alcohol Used as the dependent variable and the other offence related behavioural characteristics as the predictors (see Table 8.17) significantly predicted 79% of cases, $\chi^2(22) = 103.66, p < .0001$, and explained 36% of the variance (Nagelkerke $R^2 = .36$).

Table 8.17: Binary Logistic Regression with Alcohol Use as Dependent variable and Offence related Behaviours as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(B)
Victim Known	1.38	0.40	11.63	1	.001	4.00
Material Brought	-1.21	0.37	10.38	1	.001	0.30
Target Public Building	-2.00	0.66	9.25	1	.002	0.14
Target Vehicle	1.47	0.50	8.50	1	.004	4.33
Target School	-1.29	0.53	6.02	1	.014	0.28
Victim Ex-Partner	1.39	0.66	4.51	1	.034	4.03
Group/Solo	-0.67	0.33	4.10	1	.043	0.51

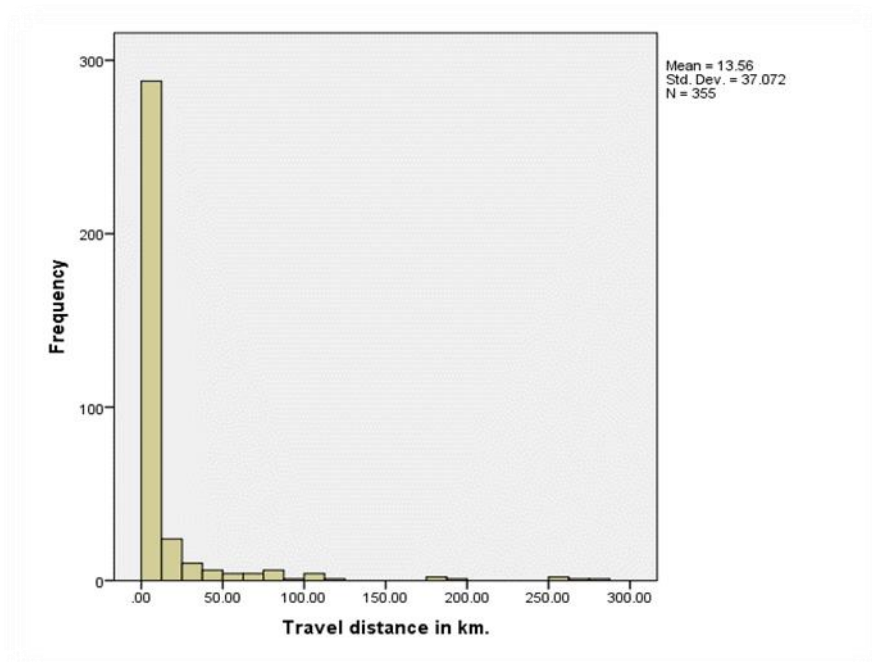
Significant predictors were: not targeting schools ($p = .014$) and public buildings ($p = .002$) and not bringing materials to the scene ($p = .001$); but targeting vehicles ($p < .004$), knowing the victim ($p = .001$), targeting an ex-partner ($p = .034$), and operating alone ($p =$

.043). The AUC value was .81 ($SE = .023$), $p < .0001$). Notably, therefore, the hypothesis that solo offenders would be more likely to use alcohol was supported.

8.6.10. Travel Distance

The mean travel distance for the sample of 355 offenders was 13.56 km ($SD = 37.07$) and the range was 275 (0 – 275 km) suggesting a wide range of travel distances. However, the median was only 1.14 km, indicating, as predicted, that the majority of offenders did not travel far to set fires; indeed, the mode was zero, reflecting the fact that 30 (8%) offenders set fire to their own homes. The frequency distribution (see Figure 1) clearly reflects this; nearly 70% of offenders set fires less than 5 km from their homes.

Figure 8.1: Travel Distances from Home to Crime Scene



As travel distance was a continuous variable, Multiple Linear Regression was considered to investigate the predictors; however, an examination of the relevant histogram and normal P-P plots of standardised residuals indicated that the data would clearly violate the homoscedasticity and linearity assumptions of MLR (Field, 2009). Nevertheless, after a

preliminary examination of the data, two main questions emerged; namely, what behaviours and characteristics best predict a) whether offenders will or will not travel to commit offences, and b) whether offenders will travel longer distances to commit offences? To answer these questions a number of classification schemes and types of regression were considered (multinomial and ordinal); however, it was decided that the perhaps the easiest and clearest way of answering these questions would be simply to apply two ‘one versus all’ (OVA) binary logistic regressions (see Rifkin and Klautau, 2004); i.e. two regressions, one classifying offenders according to whether or not they had travelled at all (0 or >0 km), the other comparing those who had travelled longer distances (≥ 5 km) with others not travelling as far (or travelling at all).

As noted previously, 30 offenders (8%) set fire at home, whereas 325 offenders (89%) travelled away from home to set fires. A binary logistic regression with Travel Distance split 0/>0 km as the dependent variable, and the other offence related behavioural characteristics as the predictors (see Table 8.18), significantly predicted 94% of cases, $\chi^2(22) = 112.09$, $p < .0001$, and explained 62% of the variance (Nagelkerke $R^2 = .62$). Significant predictors of not travelling (as distinct from travelling away from home) were, not surprisingly, setting fire to ones’ own home ($p < .005$), and endangering lives ($p = .027$). The ROC analysis showed an outstanding AUC value of .96 ($SE = .010$), $p < .0001$.

Table 8.18: Binary Logistic Regression with Travel Distance (split at 0.00 km) to the Crime Scene as Dependent variables, Offence related Behaviours as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(B)
Target Own Home	-1.96	0.69	8.06	1	.005	0.14
Lives Endangered	-2.47	1.11	4.90	1	.027	0.85

Of the 355 offenders, 110 (30%) travelled 5 km or more from home, whereas, as noted, the majority, 245 (69%), travelled less than 5 km. A binary logistic regression with Travel Distance split $\leq 5 / > 5$ km as the dependent variable and the other offence related behavioural characteristics as the predictors (see Table 8.19) significantly predicted 75% of cases, $\chi^2(22) = 56.33, p < .0001$, and explained 21% of the variance (Nagelkerke $R^2 = .21$). Significant predictors of travelling longer distances (> 5 km) were: not targeting schools ($p = .034$), but targeting vehicles ($p = .004$), knowing the victim ($p = .003$), and planning the firesetting ($p = .018$). The AUC value was .74 ($SE = .029$), $p < .0001$).

Table 8.19: Binary Logistic Regression with Travel Distance (split at 5 km) to the Crime Scene as Dependent variables, and Offence related Behaviours as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(<i>B</i>)
Victim Known	1.09	0.37	8.61	1	.003	2.98
Target Vehicle	1.32	0.46	8.40	1	.004	3.75
Planned	0.74	0.31	5.62	1	.018	2.09
Target School	-0.98	0.46	4.48	1	.034	0.38

8.7. Results: Relationship Variables

This final section summarises the frequency statistics for the relationship with victim variables that were entered as predictors entered into the above regressions (see Table 8.20).

Table 8.20: Frequency Statistics for Relationship Variables

	Present	Absent	Binomial <i>p</i>
Lives Endangered	124 (35%)	231 (65%)	< .0001
Prior Violence	66 (19%)	289 (81%)	< .0001
Prior Threats	42 (12%)	313 (88%)	< .0001
Victim Ex-Partner	20 (6%)	335 (94%)	< .0001
Victim Known	176 (50%)	179 (50%)	n.s

As can be seen, in all cases, except 'victim known', positive instances were significantly in the minority.

8.8. Discussion

The results of this study show some potentially interesting patterns of behaviour relating to targets, relationship with the victim, and crime scene behaviours, many of which have not previously been investigated in the literature on arson. These can be summarised as follows.

8.8.1. Targets

In relation to targets, clearly the main target chosen was residential property (30%), of which for a little over half of offenders (17%) involved the offender's own home, and 6% directly targeted themselves. In terms of frequency, residential as a target was followed by targeting miscellaneous (23%), and the remainder were broadly equivalent ranging from 15-18%; though businesses were a little lower (10%).

As noted, with regard to those who had used more than one target, there appeared to be four main patterns with regard to these particular targets. Thus, those who targeted residential properties were significantly more likely to target themselves and their own homes, and less likely to choose other targets; whereas those who targeted schools were significantly more likely to target public buildings, and vehicles, but less likely to target their own homes. Those who targeted businesses were less likely to target vehicles, but otherwise targeting of businesses was relatively discrete and showed non-significant negative trends as regards other targets. And, finally, those who targeted miscellaneous objects tended to be less likely to target residential buildings, public buildings and vehicles.

Some possible insights into these patterns can be gained by looking at the significant predictors of the targets involved (for both single and serial offenders). For example, the

targeting residential properties, as well as targeting oneself, was positively associated with targeting an ex-partner, endangering lives and operating alone, indicating perhaps that the motives behind the arson would more likely be personal (such as revenge or to gain from insurance fraud) rather than simply for excitement or stimulation. Significantly, according to Murphy and Maneval (1978), arson for fraud is the only organised white collar crime that is precipitated by a violent offence. Targeting residential properties was also associated with endangering lives, and give an alert during or after the fire, perhaps to indicate an 'accident' or absolve themselves of responsibility; and targeting oneself was more likely to be found among those who had shown previous violence to themselves or others, and to made use of multiple fire sites, suggesting perhaps that their efforts were of particularly serious intent.

In contrast, targeting schools was most associated with not endangering lives and planning, and targeting public buildings was more likely to occur among those who did not endanger lives, and tended to operate as a group. This suggests that the motives for arson using these latter targets may be less personal and may include stimulation and excitement. However, the finding that, for serial arsonists, there was also a connection between targeting schools and public buildings with targeting vehicles (Table 8.1), suggests not only an excitement factor in such cases, but also one of possible concealment of a crime, particularly as (for all offenders) targeting vehicles was also predicted by the use of accelerants and other firesetting materials, previous violence to victims, and not giving an alert; all possible indicators, for example, of aggravated theft, and attempting to destroy evidence (say of a getaway car).

Although there were no significant predictors of targeting businesses, the fact that serial offenders who targeted businesses were also more likely to target vehicles suggests again possible 'non-personal' criminal motives, such as insurance fraud and destroying evidence. This also potentially fits with the finding that targeting of vehicles was less likely

to occur among those who knew their victims and endangered lives; indicating perhaps that, in such cases, the vehicles were less likely to be targeted for personal reasons. Interestingly, this appears to contrast with the U.S. Fire Administration's (2014) report that the most common reason for setting a vehicle on fire is revenge; i.e. a car is seen as an extension of the personal property and, therefore, a common target for personal revenge. It is difficult to know whether this discrepancy reflects measurement issues, or a real cultural difference between arson in the USA and Denmark; either way, it would be useful to follow it up in further research. Some further comments on this will be made shortly. However, the U.S. Fire Administration also states that crime concealment is another common reason for setting fire to a vehicle, as well as other targets (i.e. to conceal burglary and larceny), which may fit better with the present results.

In light of the above, the fact that those who targeted miscellaneous objects tended to be less likely to target residential buildings, public buildings and vehicles suggests that the motives may well have been more opportunist and more a result of factors such as boredom (rather than revenge or more serious criminal intent). This is also supported by the findings of the regression analysis showing that targeting miscellaneous items was associated with not endangering lives, not using an accelerant, and not setting fire multiple sites, but was more likely to co-occur with giving an alert during or after the fire.

8.8.2. Crime Scene Variables

The results indicated that a substantial minority of offenders (41%) planned their firesetting. Planning was negatively associated with targeting schools, vehicles and miscellaneous items, but positively with knowing and showing prior violence towards the victim, deliberately endangering lives and bringing additional firesetting materials to the crime scene. Together these findings could be interpreted as suggesting that, although many arsonists may plan their

offences for a variety of reasons, this particularly seems to be the case for those with personal motives such as revenge or some sort of personal vendetta; i.e. planning could be a hallmark of those who deliberately seek to harm someone in particular.

Also, as mentioned in Chapter 7, a large minority of offenders offended on their own (44%). In the present study, not only was solo offending particularly associated with targeting residential properties, it was also associated with showing prior violence to the victim as distinct from threatening the victim. Because there is some evidence to suggest that solo offenders tend to be psychologically disturbed and have a psychiatric history (Wood, 2000) it was also predicted that they might also be inclined to plan attacks using accelerants. In line with this, Goldweber, Dmitrieva, Cauffman and Piquero (2011) proposed that solo offenders are more psychologically mature than group offenders and, therefore, they might even plan their offences to a higher degree. However, in the present sample, there no association between planning and group offending, and it was actually group offending that was associated with using accelerants, as well as bringing other firesetting materials to the scene. There appears to be no obvious explanation for this, though one possibility is that when offenders are in groups there is more likelihood that one or other group members to acquire more specialist accelerant materials and related expertise; i.e. the acquisition of specialist accelerant materials may, in itself, be facilitated by group planning.

Firing multiple sites was associated with firing multiple items, as well as targeting residential properties, businesses, and schools and deliberately endangering lives. Firing multiple fire sites together with multiple items could be construed as another indicator of determination in firesetting. However, firing multiple sites was significantly negatively associated with violence to the victim, possibly suggesting, for example, that firing multiple sites may be associated with more impersonal motives such as fraud, or perhaps a recourse for those not usually prone to violence. However, firing multiple items, as a variable in itself,

seemed to be associated with a particularly diverse range of targets, such as schools, public buildings, own home and miscellaneous items. This suggests, perhaps, that of itself, firing multiple items may also be a feature of offenders who may be experimenting with setting fires, rather than selecting specific targets or individuals.

Contrary to some previous findings (see Sapp, Hobort et al. (1994), the majority of offenders did not use an accelerant (54%); however, the difference in the frequency of use and non-use was not statistically significant. When used as a dependent variable, use of accelerants was significantly predicted not only by targeting vehicles, offending in groups and not targeting themselves, but also targeting businesses, knowing the victim/s, and using multiple sites. Taken together, arguably these could be construed more as indicators of a positive relationship between the use of accelerants and more general organised criminal activity.

Perhaps not surprisingly, when entered as a dependent variable, bringing more general (unplanned or relatively unplanned) firesetting materials to the crime scene (which occurred in slightly more cases, i.e. 50%) appeared to be predicted by a rather wider range of factors, including multiple targets (schools, public buildings, vehicles, and miscellaneous objects, but not self), planning the offence, and not using alcohol, as well as, again, knowing the victim and operating as a group. However, arguably these could still be construed primarily as indicators of more planned and organised criminal activity as distinct from opportunistic offending or arson committed for more personal reasons.

A significant majority of offenders did not give an alert during or after the fire (78%). However, when giving an alert during or after the fire was entered as the dependent variable the significant predictors were somewhat limited; i.e. residential and miscellaneous targets, multiple items fired, and remained returned. Notably, this would appear to be in line with the fact that residential properties were also the most frequently chosen targets. These results

suggest perhaps that giving an alert may be more likely when a) as mentioned previously, offenders firing properties, particularly residential targets, are trying to indicate that the fire is an ‘accident’, absolve themselves of responsibility, or limit damage, and or b) the offence is for excitement or stimulation (hence miscellaneous targets too), so that offenders wish to stay around or return to witness the results of their endeavours, including its effects on others. In fact, the latter would appear to fit the stereotype of Lewis and Yarnell’s (1951) and Inciadi’s (1970) ‘excitement arsonist’, who not only may like setting or watching fires, but even enjoy viewing the operations of the firefighters and fire equipment.

However, rather fewer offenders remained/returned to the fire, though the proportion (33%) is very similar to that reported by Sapp, Hobort et al. (1994). Moreover, when remained/returned by itself was entered as a dependent variable the pattern of significant predictors was slightly different; i.e. not targeting schools, but targeting own home, endangering lives, and giving an alert. Nevertheless, it could be argued that this pattern endorses the fact that giving an alert and staying or returning to the fire are characteristics not limited to ‘excitement arsonists’, but may also encompass characteristics of offenders who are targeting residential properties, including their own for other reasons, such as revenge, fraud and/or self-harm.

Although a number of studies have indicated the very wide use of alcohol during arson offending (see, for example, Dickens et al., 2012; Fritzson et al., 2001; Wood, 1999), only 31% of the offenders in the present sample were under the influence of alcohol at the time of the crime. This is actually lower than recent estimates of the use of alcohol in violent crimes in the UK (Office for National Statistics, 2015); though arguably it is still a sizeable proportion. Significant predictors for alcohol use at the time of the crime were less likely to target schools and public buildings and to bring fire-setting materials to the crime scene, but more likely to target a vehicle, and operate alone, as well as know the victim and target an ex-

partner. Interestingly, in the 2015 UK crime survey, 38% of victims were under the influence of alcohol when the offender was a stranger compared with 14% when the offender was a partner/ex-partner. In the current sample the offender was more likely to be under the influence of alcohol, when he or she knew the victim, suggesting that this may be an identifying feature of arson behaviour. Indeed, the predictors of operating alone, knowing the victim and targeting partner appear to fit with Felson and Staff's (2010) finding that alcohol use was greater with dispute-related violence.

However, given these considerations, the fact that targeting a vehicle also emerged as a significant predictor of alcohol use seems somewhat at odds with the finding reported above that those who targeted vehicles were less likely to know their victims; i.e. the vehicle was not targeted for personal reasons. Indeed, it is more in line with the aforementioned U.S. Fire Administration's (2014) report regarding revenge as a primary motive for targeting vehicles. Nevertheless, the critical factor here appears to be alcohol use; if one examines the zero-order associations, as a general tendency, targeting vehicles is actually associated with *not* knowing the victim ($\Phi = -.27, p < .0001$). However, targeting a vehicle is also positively associated with alcohol use ($\Phi = .13, p = .016$), and alcohol use is associated with *knowing* the offender ($\Phi = -.21, p < .0001$). So, put another way, although as a general tendency, targeting vehicles was associated with not knowing the victim, the reverse appeared to be the case when alcohol was involved.

8.8.3. Travel Distance

Finally, the mean travel distance was 13.6 km. This is considerably greater than mean travel distances reported not only for arson but many other kinds of crime (Fritzon, 2001; Harling, 1972). Indeed, as mentioned in Chapter 2, in Fritzon's (2001) sample of 156 arson cases the overall mean was only 2.1km from home to crime scene (range 0km to 116.2 km). However,

the range (0 – 275 km) was considerably larger in the present sample and the median 1.14 km was clearly more in line with predictions.

The regression analyses showed few significant predictors of travel distance in terms of the other offence related characteristics; most notably, the main predictors of not travelling at all (8% of cases) were endangering lives and targeting one's own home. Most offenders (69%) travelled 5km or less; it can be noted here that Wilson and Alison (2005) also used 5km as a critical point for splitting data in their study of sex offenders (74% of sex offences were committed within 5km of the offender's home). In the present sample, the main predictors of travelling over 5km were less likely to target a school, but more likely to target a vehicle, plan the firesetting and know the victim. Interestingly, one can see a possible overlap here with Fritzon's (2001) proposal that very short travelling distances (< 1 km) are more associated with and acts of despair, and attention seeking behaviour, whereas longer distances are associated more with revenge, or generally as a planned attack against a specific person; in the latter case the offence is targeted at specific location and where identity of the perpetrator can best be concealed. In the latter case, the vehicle could be a target not only because it might belong to the victim (in which case the owner would be known), but also because it was used to drive to the location of the main arson and then fired to conceal the evidence (in which case the owner of the fired vehicle might not be known, but the specific targeted victim of the main arson might be).

8.8.4. Overall Consideration of Variables

As noted in the introductory chapters, as in arson research generally, to make sense of patterns of data, rather than simply describing them, it is difficult to avoid making inferences about possible motivation, even though motives were not investigated specifically. And, indeed, the above summary and related discussion well illustrates this. Moreover, in turn, this

approach naturally leads to speculation about which of theoretical viewpoint or viewpoints reviewed in Chapter 2 might best represent the present findings in this respect. Arguably, given the nature of the above discussion, perhaps one of the most obvious arson models to apply here would be that of Inciardi (1970), who variously classified arson offenders 'revenge arsonists', 'excitement arsonists', 'insurance claim arsonists', 'vandalism offenders' and 'crime concealers'. All of these categories could be reasonably be inferred as applying to the results of the present study, and, on first consideration at least, they more obviously make sense of the data than more simple categorisations such as instrumental and intrinsic (Faulk, 1994), or organised and disorganised offending (Douglas et al., 1992), or alternatives such as Canter and Fritzon's (1998) instrumental/expressive, person/object categorisation, or Kocsis and Cooksay's (2002) thrill, anger, wanton, and sexual categories. Though even then, Inciardi's categories do not seem to capture in any obvious the full range of behaviours investigated in the present study, an obvious omission being self-harm.

Perhaps the most comprehensive, empirically based classification for arson offence behaviours is that of Santilla, Fritzon and Tamelander (2004), which was based on a sample of Finnish arsonists. Using principal components analysis, they identified factors derived from crime scene behaviours which they labelled as 'expressive person', 'expressive object' 'instrumental person', 'destroy', and 'adaptive'. However, they used data from only 42 arsonists, their analysis again concentrated on attempting to group variables into a small number of factors, rather, as here, examining relationships between individual offence behaviours and the other variables. As such, their results are not really comparable with those in the present study.

This draws attention to the critical point, emphasised in Chapter 5, that the whole idea of attempting to make sense of forensic data by applying models that attempt to group the data into a small number of discrete, or even overlapping factors or clusters, and then

making subjective inferences about the meanings of those clusters, has been seriously questioned. The main problems are that the groupings and labelling often show poor consistency and reliability and are open to different interpretations, (see Gannon & Pina, 2010), and also they are invariably too blunt a tool for capturing a wide range of behaviours across a number of situations, and therefore, when tested using statistical criteria, have relatively poor predictive value (see Alison, Bennell, Mokros, & Ormerod, 2002; Alison, West, & Goodwill, 2004; Goodwill et al., 2009; Woodhams & Toye, 2007).

At this stage, therefore, in line with the approach advocated by Goodwill et al. (2009), the main emphasis in the present thesis was not on imposing some kind of global theoretical structure on the results for the offence related variables, but simply on gathering as much summary data as possible about the individual variables from the information available. The ultimate aim was then to use these summary data to devise an item or variable based system or chart for capturing the data; this is presented in the final General Discussion section of this thesis. To further this end, therefore, the next study investigates demographic and biographical characteristics as predictors of the offence related behavioural variables.

As a final point regarding the present study, however, it may be useful to emphasise that, with exception of the targeting business properties, all of the regression models and their associated AUC values were significant, indicating that, as a general principle, it may be possible to predict particular offence related behaviours and characteristics from others in a statistically reliable way; i.e. there may be elements of consistency in the way arson offences are conducted. However, there were also obvious differences between the various offences; different offence related characteristics were associated with different sets of predictors. These two characteristics, consistency and distinctiveness, have been demonstrated for a variety of crimes (see, Woodhams & Toye, 2007), including arson (Santilla, Fritzon & Tamelander, 2004). However, to the best of the researcher's knowledge, the present studies

are the first time that the method of using a series of regressions to predict individual arson offences characteristics from other offence related characteristics has been employed in this respect (rather than statistically grouping characteristics through procedures such as SSA, or factor and principal components analysis).

Chapter 9

Study 4 – Offence Related Behaviours and Demographic and Biographical Characteristics of Arsonists

9.1. Introduction

This next study, Study 4, investigates possible demographic and biographical predictors of the various offence related variables. As in the previous chapter, the primary investigative statistical technique used was binary logistic regression.

9.2. Entry of Demographic and Biographical Variables

In the regression analyses in this study, the following demographic and biographical predictors were used: previous convictions for arson, all previous convictions, all previous convictions excluding arson, criminal damage, ethnicity, nationality, urban/rural, gender, age (first offence), under 18/18 and over (first offence), living/has been in an institution, living with parents, enrolled at school, unemployed, manual worker, psychiatric history, history of alcoholism, and trouble at school. It can be noted that ‘criminal damage’ and ‘under 18/18 and over’ were included at this point specifically because Edwards and Grace (2014) had identified them as significant predictors of arson recidivism (n.b. Edwards and Grace entered both ‘age’ as a continuous variable and as a binary split, simultaneously, as predictors in their regressions) (For a summary of the codings of variables used in this chapter see Appendix 1 and 5).

However, as in all multiple regression analyses, one issue that can arise in binary logistic regression is that of excessive correlations or associations between predictor variables. If too many predictors are very highly correlated, this can have the effect of inflating Type II errors, leading to more conservative conclusions (Midi, Sarkar & Rana, 2013). The general rule of thumb for binary logistic regression is that this is only an issue if the Phi coefficients and/or correlations exceed .80 (see Midi et al., 2013; Tabachnick and Fidell, 2012). In the regressions in this thesis, none of the associations approached .80, with the exception of the obvious association in the next study (Study 4), between a) all convictions, and all convictions including arson ($\Phi = .74$), b) nationality and ethnicity ($\Phi = .87$), and, as just mentioned, c) age of first offence as a continuous variable, and age of first offence split as under 18 years, or 18 and older ($r_{pb} = .77$). However, selective removal of the alternatives in each case had virtually no effect on the other variables or model statistics, so in all three cases, both variables were included. For reasons of space, only significant results are presented; however, full tables can be obtained from the researcher. Zero-order correlations/Phis between the Offence related variables are presented in Appendix 6.

9.3. Hypotheses

The main hypotheses were as follows.

1. Those who have a psychiatric diagnosis will be more likely to use an accelerant, bring fire lighting materials with them, offend under the influence of alcohol and more likely to know their victims.

2. Overall, travel distances will be shorter in urban areas, and where there are environmental obstacles. Travel distances will also be mediated by age and gender; hence older offenders will tend to travel further. However, the hypothesis for gender was two-tailed as what little literature there is on the subject is contradictory.

9.4. Results

9.4.1. Target Residential

A BLR with Residential Target as the dependent variable and the demographic and biographical characteristics as the predictors (see Table 9.1) significantly predicted 79% of cases, $\chi^2(18) = 90.08, p < .0001$, and explained 32% of the variance (Nagelkerkel $R^2 = .32$). Significant predictors for targeting residential properties were: being female ($p = .003$), being older at the time of first offence ($p = .025$), and having a history of alcoholism ($p = .016$). The AUC value was .77 ($SE = .029$), $p < .0001$.

Table 9.1: Binary Logistic Regression with Residential Target as Dependent variable, and Demographic and Biographical Variables as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp (B)
Gender	-1.10	0.38	8.53	1	.003	0.33
Alcoholism	0.92	0.38	5.78	1	.016	2.50
Age	0.04	0.02	5.01	1	.025	1.04

9.4.2. Target Business

The same regression with Business Target as the dependent variable (see Table 9.2) significantly predicted 90% of cases, $\chi^2(18) = 16.66, p < .0001$, but explained only 9% of the variance (Nagelkerkel $R^2 = .09$). Significant predictors for targeting business properties were: more likely to have other convictions excluding arson ($p = .045$), and be less likely to have a psychiatric history ($p = .018$). Though highly significant, the AUC value was only ‘acceptable’ at .68 ($SE = .05$), $p < .0001$.

Table 9.2: Binary Logistic Regression with Business Target as Dependent variable, and Demographic and Biographical Variables as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(B)
Psychiatric History	-1.70	0.72	5.61	1	.018	0.18
Convictions Excluding Arson	1.56	0.78	4.02	1	.045	4.75

9.4.3. Target School

The regression with School Target as the dependent variable (see Table 9.3) significantly predicted 86% of cases, $\chi^2 (18) = 91.05, p < .0001$, and explained 38% of the variance (Nagelkerkel $R^2 = .38$). Significant predictors for targeting a school property were: more likely to have be living with parents ($p < .0001$), and less likely to be unemployed ($p = .003$). The AUC value was ‘excellent’ at .84 ($SE = .03$), $p < .0001$.

Table 9.3: Binary Logistic Regression with School Target as Dependent variable, Demographic and Biographical Variables as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(B)
Living With Parents	3.11	0.82	14.22	1	.0001	22.39
Unemployed	-1.43	0.48	8.77	1	.003	0.24

9.4.4. Target Public Building

The regression with Public Building as the dependent variable (see Table 9.4) significantly predicted 88% of cases, $\chi^2 (18) = 65.22, p < .0001$, and explained 29% of the variance (Nagelkerkel $R^2 = .29$).

Table 9.4: Binary Logistic Regression with Public Building as Dependent variable, and Demographic and Biographical Variables as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(B)
Psychiatric History	1.76	0.73	5.84	1	.016	5.78
Urban/Rural	0.85	0.37	5.21	1	.022	2.33
Gender	1.63	0.74	4.81	1	.028	5.09
Convictions Excluding Arson	-1.59	0.72	4.85	1	.028	0.21

Significant predictors of targeting a public building were: more likely to be an urban offender ($p = .022$), be male offenders ($p = .028$), and have a psychiatric history ($p = .016$).

Additionally the group were less likely to have convictions other than arson ($p = .028$). The AUC value was .81 ($SE = .03$), $p < .0001$.

9.4.5. Target Vehicle

The regression with Vehicle Target as the dependent variable (see Table 9.5) significantly predicted 86% of cases, $\chi^2(18) = 87.60$, $p < .0001$, and explained 37% of the variance (Nagelkerkel $R^2 = .37$). Significant predictors of targeting a vehicle were: less likely to be a school pupil ($p < .0001$), to have a psychiatric history ($p = .045$), and to have issues with alcohol ($p = .027$) and more likely to be younger at the time of first offence ($p = .006$). The AUC value was .84 ($SE = .03$), $p < .0001$.

Table 9.5: Binary Logistic Regression with Vehicle Target as Dependent variable, and Demographic and Biographical Variables as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(B)
School Pupil	-1.92	0.54	12.85	1	.0001	0.15
Age	-0.09	0.03	7.64	1	.006	0.91
Alcoholism	-1.34	0.61	4.86	1	.027	0.26
Psychiatric History	-1.42	0.71	4.00	1	.045	0.24

9.4.6. Target Miscellaneous

The regression with Miscellaneous Target as the dependent variable (see Table 9.6) significantly predicted 80% of cases, $\chi^2(18) = 43.43$, $p < .0001$, and explained 17% of the variance (Nagelkerkel $R^2 = .17$). However, there was only one significant predictor of targeting miscellaneous items: more likely to have prior convictions for all offences ($p = .028$). None of the other predictors approached significance. Notwithstanding this, the AUC value was ‘acceptable’ at .73 ($SE = .03$), $p < .0001$.

Table 9.6: Binary Logistic Regression with Miscellaneous Target as Dependent variable, and Demographic and Biographical Variables as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(<i>B</i>)
Convictions All	1.12	0.51	4.82	1	.028	3.05

9.4.7. Target Self

The regression with Target Self as the dependent variable (see Table 9.7) significantly predicted 96% of cases, $\chi^2(18) = 83.22, p < .0001$, and explained 56% of the variance (Nagelkerke $R^2 = .56$). Significant predictors for targeting ones-self were: more likely to be female ($p = .021$), to be over 18 years old at the time of first offence ($p = .030$), and to have been in an institution at some point ($p = .004$). The AUC value was ‘outstanding’ at .95 ($SE = .023$), $p < .0001$.

Table 9.7: Binary Logistic Regression with Self as Dependent variable, and Demographic and Biographical Variables as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(<i>B</i>)
Institution	2.28	0.79	8.38	1	.004	9.80
Gender	-1.64	0.71	5.30	1	.021	0.19
Under/Over18	3.11	1.43	4.71	1	.030	22.35

Although not a formal hypothesis, it might seem surprising that targeting oneself was not predicted by the presence of psychiatric history; in fact, the zero-order association between psychiatric history and targeting self was positive and significant, $\Phi = .37, p < .0001$). Correspondingly, a rerun of the regression showed that psychiatric history did significantly predict targeting self when entered by itself, but it ceased to be a significant predictor when the other three significant predictors (female gender, 18 and over, and living/have lived in an institution) were entered. This suggests that psychiatric history relates to targeting self primarily through its association with these variables. And, indeed, the zero-

order associations between psychiatric history and gender, 18 and over, and living/have lived in an institution, were all highly significant ($\Phi = -.26, .49, \text{ and } .42, p < .0001$, respectively).

9.4.8. Target Own Home

The regression with Target Own Home as the dependent variable (see Table 9.8) significantly predicted 89% of cases, $\chi^2 (18) = 119.30, p < .0001$, and explained 48% of the variance (Nagelkerkel $R^2 = .48$). Significant predictors of targeting own home were: more likely to be female ($p = .011$), and to have been in an institution at some point ($p < .0001$). The AUC value was ‘excellent’ at .88 ($SE = .028$), $p < .0001$.

Table 9.8: Binary Logistic Regression with Own Home as Dependent variable, and Demographic and Biographical Variables as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(B)
Institution	1.99	0.57	12.41	1	.0001	7.34
Gender	-1.24	0.49	6.51	1	.011	0.29

9.4.9. Victim Known

The regression with Victim Known as the dependent variable (see Table 9.9) significantly predicted 72% of cases, $\chi^2 (18) = 90.33, p < .0001$, and explained 30% of the variance (Nagelkerkel $R^2 = .30$). Significant predictors of Victim Known were: more likely to have other convictions than arson ($p = .025$), and to be older at the time of first offence ($p = .006$). The AUC value was .77 ($SE = .025$), $p < .0001$.

There was, therefore, no support in the regression for the hypothesis that those with a psychiatric history would be more likely to know their victim; however, the zero-order Phi association between the two was significant and in line with the hypothesis, $\Phi = .33, p < .0001$.

Table 9.9: Binary Logistic Regression with Victim Known as Dependent variable, and Demographic and Biographical Variables as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(B)
Age	0.05	0.02	7.70	1	.006	1.06
Convictions Excluding Arson	1.04	0.46	5.05	1	.025	2.83

A selective rerun of the regression showed that psychiatric history ceased to be a significant predictor when age of first offence was entered in the regression. As is indicated by the other relevant zero-order associations, this suggests that one of the main reasons why psychiatric history may be predictive of knowing the victim is through its association with age; i.e. those with a psychiatric history tend to be older at the time of first offence ($\Phi = .54$, $p < .0001$) and those who are older are more likely to target victims they know ($\Phi = .40$, $p < .0001$).

9.4.10. Victim Ex-partner

The regression with Victim Ex-partner as the dependent variable (see Table 9.10) significantly predicted 94% of cases, $\chi^2(18) = 66.65$, $p < .0001$, and explained 41% of the variance (Nagelkerke $R^2 = .41$). There was only one significant predictor, less likely to be unemployed ($p = .046$); though being older at the time of first offence just narrowly missed being significant ($p = .052$). The AUC value was .92 ($SE = .023$), $p < .0001$.

Table 9.10: Binary Logistic Regression with Victim Ex-partner as Dependent variable, and Demographic and Biographical Variables as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(B)
Unemployed	-1.54	0.77	3.99	1	.046	0.21
Age	.052	0.027	3.78	1	.052	1.05

9.4.11. Prior Violence Towards Victim

The regression with Prior Violence Towards Victim as the dependent variable (see Table 9.11) significantly predicted 84% of cases, $\chi^2(18) = 98.59, p < .0001$, and explained 39% of the variance (Nagelkerke $R^2 = .39$). Significant predictors of prior violence towards the victim were: more likely to be a rural offender ($p = .049$), and to have a psychiatric history ($p = .010$); and less likely to be living with parents at the time of the offence/s ($p = .007$). The AUC value was .86 ($SE = .027$), $p < .0001$.

Table 9.11: Binary Logistic Regression with Prior Violence Towards Victim as Dependent variable, and Demographic and Biographical Variables as Predictors

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(B)
Living With Parents	-1.64	0.61	7.30	1	.007	0.19
Psychiatric History	1.07	0.42	6.58	1	.010	2.92
Urban/rural	-0.81	0.41	3.89	1	.049	0.45

9.4.12. Prior Threats Towards Victim

The regression with Prior Threats Towards Victim as the dependent variable, significantly predicted 88% of cases, $\chi^2(18) = 19.64, p < .0001$, but only explained 10% of the variance (Nagelkerke $R^2 = .10$). Moreover, no individual predictors approached significance; also, the AUC value, though significant, was classified as ‘poor’ at .69 ($SE = .040$), $p < .0001$.

9.4.13. Lives Endangered

The regression with Lives Endangered as the dependent variable (see Table 9.12) significantly predicted 78% of cases, $\chi^2(18) = 119.91, p < .0001$, and explained 40% of the variance (Nagelkerke $R^2 = .40$). Significant predictors of endangering lives were: more likely to be female ($p = .001$), and to have a psychiatric history ($p < .0001$). The AUC value was .81 ($SE = .025$), $p < .0001$.

Table 9.12: Binary Logistic Regression with Lives Endangered as Dependent variable, and Demographic and Biographical Variables as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(<i>B</i>)
Psychiatric History	1.50	0.42	13.15	1	.0001	4.50
Gender	-1.36	0.40	11.30	1	.001	0.26

9.4.14. Arson Planned

The regression with Arson Planned as the dependent variable (see Table 9.13) significantly predicted 70% of cases, $\chi^2(18) = 50.86, p < .0001$, and explained 18% of the variance (Nagelkerke $R^2 = .18$).

Table 9.13: Binary Logistic Regression with Arson Planned as Dependent variable, and Demographic and Biographical Variables as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(<i>B</i>)
Urban/Rural	-0.83	0.26	9.89	1	.002	0.44
Living With Parents	-1.41	0.45	9.97	1	.002	0.25
Institution	-1.36	0.47	8.30	1	.004	0.26
Age	-0.05	0.02	7.84	1	.005	0.95
Ethnicity	1.60	0.80	3.96	1	.047	4.94

Significant predictors of planning arson were: more likely to be White ($p = .047$), to be younger at the time of first offence ($p = .005$), and to be rural offenders ($p = .002$); but less likely to have been living in an institution ($p = .004$), and living with parents ($p = .002$). The AUC value was .71 ($SE = .03$), $p < .0001$.

9.4.15. Group/solo/Solo Offending

The regression with Group/Solo Group/soloOffending as the dependent variable (see Table 9.14) significantly predicted 79% of cases, $\chi^2(18) = 164.49, p < .0001$, and explained 50% of the variance (Nagelkerke $R^2 = .50$). Significant predictors of offending in a group were: more

likely to have had previous arson convictions ($p = .010$), and be a school pupil ($p = .001$); whereas predictors of solo offending were: more likely to have convictions for criminal damage ($p = .014$), be rural offenders ($p = .031$), have a psychiatric history ($p = .012$), have been in trouble in school ($p = .003$) and to be older at the time of first offence ($p = .004$). The AUC value was .86 ($SE = .02$), $p < .0001$.

Table 9.14: Binary Logistic Regression with Group/solo Offending as Dependent variable, and Demographic and Biographical Variables as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(B)
School Pupil	1.44	0.44	10.47	1	.001	4.21
School Trouble	-1.30	0.45	8.55	1	.003	0.27
Age	-0.07	0.02	8.19	1	.004	0.93
Previous Arson	1.20	0.47	6.68	1	.010	3.33
Psychiatric History	-1.22	0.48	6.36	1	.012	0.30
Criminal Damage	-1.41	0.57	6.05	1	.014	0.25
Urban/rural	-0.67	0.31	4.63	1	.031	0.51

9.4.16. Multiple Items Fired

The regression with Multiple Items Fired as the dependent variable and the demographic and biographical characteristics as the predictors (see Table 9.15) significantly predicted 91% of cases, $\chi^2(18) = 39.10$, $p < .0001$, and explained 20% of the variance (Nagelkerkel $R^2 = .20$). However, there was only one predictor approaching significance and this was, less likely to be unemployed ($p = .067$). Notwithstanding this, the AUC value was ‘acceptable’ at .72 ($SE = .046$), $p < .0001$.

Table 9.15: Binary Logistic Regression with Multiple Items Fired as Dependent variable, and Demographic and Biographical Variables as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(B)
Unemployed	-0.87	0.48	3.35	1	.067	0.42

9.4.17. Multiple Sites

The regression with Firing Multiple Sites as the dependent variable (see Table 9.16) significantly predicted 81% of cases, $\chi^2(18) = 44.01, p < .0001$, and explained 18% of the variance (Nagelkerke $R^2 = .18$).

Table 9.16: Binary Logistic Regression with Multiple Sites as Dependent variable, and Demographic and Biographical Variables as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(B)
Unemployed	-0.96	0.40	5.82	1	.016	0.38
School Trouble	0.90	0.40	5.13	1	.023	2.47
Gender	-0.79	0.39	4.11	1	.043	0.46

Significant predictors of setting fire to multiple sites were: more likely to be female ($p = .043$), and to have been in trouble in school ($p = .23$) and less likely to have been unemployed ($p = .016$). The AUC value was .73 ($SE = .04$), $p < .0001$.

9.4.18. Accelerant Used

The regression with Accelerant Used as the dependent variable (see Table 9.17) significantly predicted 63% of cases, $\chi^2(18) = 65.19, p < .0001$, and explained 22% of the variance (Nagelkerke $R^2 = .22$). Significant predictors of using an accelerant were: more likely to have had previous convictions including arson ($p = .021$), and have previous convictions excluding arson ($p = .003$); but less likely to have had a conviction for criminal damage ($p = .020$), have been institutionalised ($p = .006$), have been a school pupil whilst fire-setting ($p = .009$), and been in trouble at school ($p = .005$). The AUC value was .72 ($SE = .03$), $p < .0001$.

Table 9.17: Binary Logistic Regression with Accelerant Used as Dependent variable, and Demographic and Biographical Variables as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(B)
Convictions Excluding Arson	1.39	0.46	8.977	1	.003	4.02
School Trouble	-1.13	0.40	7.846	1	.005	0.32
Institution	-1.38	0.50	7.544	1	.006	0.25
School Pupil	-1.13	0.43	6.812	1	.009	0.32
Criminal Damage	-1.15	0.49	5.443	1	.020	0.32
Previous Arson	0.95	0.41	5.313	1	.021	2.60

There was, therefore, no support for the hypothesis that those with a psychiatric history would be more likely to use an accelerant (the zero-order association between the two was also not significant, $\Phi = -.047, p = .372$).

9.4.19. Materials Brought

The regression with Materials Brought as the dependent variable (see Table 9.18) significantly predicted 63% of cases, $\chi^2(18) = 55.26, p < .0001$, and explained 19% of the variance (Nagelkerke $R^2 = .19$). Significant predictors of bringing materials for fire-setting were: more likely to be male ($p = .011$) and to be younger at the time of first offence ($p = .011$) but less likely to have a conviction for criminal damage ($p = .020$), and be employed in manual work ($p = .018$). The AUC value was .71 ($SE = .03$), $p < .0001$. Again, however, there was no support for the hypothesis that those with a psychiatric history would be more likely to bring materials to the crime scene. Indeed the zero-order Phi association between the two was significantly negative, $\Phi = -.165, p = .002$).

A selective rerun of the regression showed that (lack of) psychiatric history ceased to be a significant predictor when age of first offence was entered in the regression. This suggests that one of the main reasons why an absence of psychiatric history may be

predictive of bringing materials to the scene is that those with a psychiatric history tend to be older, whereas it is younger offenders who are more likely to bring materials.

Table 9.18: Binary Logistic Regression with Materials Brought as Dependent variable, and Demographic and Biographical Variables as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(B)
Age	-0.05	0.02	6.53	1	.011	0.96
Gender	0.93	0.37	6.28	1	.012	2.53
Manual Work	-1.23	0.52	5.62	1	.018	0.29
Criminal Damage	-1.11	0.48	5.45	1	.020	0.33

9.4.20. Alert During or After Fire

The regression with Alert During or After Fire as the dependent variable and the demographic and biographical characteristics as the predictors (see Table 9.19) significantly predicted 79% of cases, $\chi^2(18) = 57.46, p < .0001$, and explained 23% of the variance (Nagelkerke $R^2 = .23$). Significant predictors of alerting others during or after the fire-setting were: more likely to have other convictions excluding arson ($p = .008$), have a history of alcoholism ($p = .001$) and be an urban offender ($p = .004$) but less likely to have a conviction for criminal damage ($p = .003$). The AUC value was .76 ($SE = .03$), $p < .0001$.

Table 9.19: Binary Logistic Regression with Alert During or After Fire as Dependent variable, and Demographic and Biographical Variables as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(B)
Alcoholism History	1.49	0.44	11.52	1	.001	4.44
Criminal Damage	-2.06	0.70	8.70	1	.003	0.13
Urban/rural	0.89	0.31	8.28	1	.004	2.44
Convictions Excluding Arson	1.48	0.56	6.98	1	.008	4.38

9.4.21. Remained at Crime Scene

The regression with Remained at Crime Scene as the dependent variable (see Table 9.20) significantly predicted 76% of cases, $\chi^2(18) = 64.64, p < .0001$, and explained 24% of the variance (Nagelkerke $R^2 = .23$). Significant predictors of remaining at the crime scene after the fire-setting were: more likely to be over 18 years old ($p = .003$), and have a psychiatric history ($p = .009$) whilst less likely to have previous convictions including arson ($p = .039$). The AUC value was $.75 (SE = .03), p < .0001$.

Table 9.20: Binary Logistic Regression with Remained at Crime Scene as Dependent variable, and Demographic and Biographical Variables as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(B)
Under/Over 18	1.59	0.53	9.04	1	.003	4.93
Psychiatric History	1.02	0.39	6.75	1	.009	2.78
Convictions All	-1.05	0.51	4.27	1	.039	0.35

9.4.22. Use of Alcohol During Fire-setting

The regression with Use of Alcohol During Fire-setting as the dependent variable (see Table 9.21) significantly predicted 82% of cases, $\chi^2(18) = 164.82, p < .0001$, and explained 52% of the variance (Nagelkerke $R^2 = .52$). Significant predictors of use of alcohol during fire-setting were: more likely to have a previous conviction for criminal damage ($p = .001$), be a rural offender ($p < .0001$), be over 18 years of age at the time of first offence ($p = .029$), and have a history of alcoholism ($p < .0001$); but less likely to have lived in an institution ($p = .049$) and have a psychiatric history ($p = .002$). The AUC value was $.87 (SE = .02), p < .0001$.

The hypothesis that those with a psychiatric history would be more likely use alcohol during fire-setting was again not supported. Indeed, the opposite was the case, in that those without a psychiatric history were significantly more likely use alcohol during fire-setting.

Table 9.21: Binary Logistic Regression with Use of Alcohol During Fire-setting as Dependent variable, and Demographic and Biographical Variables as Predictors.

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(<i>B</i>)
Alcoholism History	2.58	0.50	26.27	1	.0001	13.13
Urban/rural	-1.30	0.36	12.90	1	.0001	0.27
Criminal Damage	1.94	0.60	10.46	1	.001	6.94
Psychiatric History	-1.58	0.51	9.48	1	.002	0.21
UnderOver18	1.23	0.56	4.78	1	.029	3.43
Institution	-1.09	0.55	3.88	1	.049	0.34

9.4.23. Travel Distance

Gender, Age and Urban Rural differences. As there were specific hypotheses related to travel distance and gender and urban/rural differences, and given the emphasis that has been placed on travel distance in the literature, before performing the corresponding regressions, the data were first analysed in terms of urban/rural, gender and age using standard ANOVA procedures. The results for travel distance as a continuous variable according to gender and urban/rural area are shown in Table 9.22.

A 2 x 2 (gender x urban/rural) ANOVA on the travel distance data (as a continuous variable) found a significant main effect for urban/rural location, $F(1,351) = 25.43, p = .006, \eta^2_p = .021$. As hypothesised, those living in rural areas tended to travel further. However, there was no significant main effect for gender, $F(1,351) = 0.481, p = .488, \eta^2_p = .001$ and the interaction was not significant, $F(1,351) = 0.112, p = .738, \eta^2_p = .0001$.

Table 9.22: Descriptive Statistics for Travel Distance by Gender and Urban/rural area (km)

		<i>N</i>	Median	Mode	Mean (<i>SD</i>)	Percentage	Range
Urban	Total	142	1.03	0	5.43 (16.23)	40	105.12 (0.00 – 105.12)
	Male	115	0.89	0	5.06 (15.29)	81	100.10 (0.00 – 11.10)
	Female	27	1.64	0	7.01 (20.04)	19	105.12 (0.00 – 105.12)
Rural	Total	213	1.73	0	18.99 (45.23)	60	275.00 (0.00 – 275.00)
	Male	186	1.99	0	18.28 (44.12)	87	275.00 (0.00 – 275.00)
	Female	27	0.62	0	23.86 (52.94)	13	196.44 (0.00 – 196.44)

With regard to age at first offence, a Spearman's Correlation between travel distance and age of first offence was positive and significant, $r^s = .20$, $p < .0001$; i.e. those who travelled further tended to be older. However, given the highly skewed nature of the distribution, and the fact that 30 (8%) offenders set fire to their own homes (see Figure 8.1), two further 2 x 2 ANOVAs (gender x short/long distance) were run on the age data using the binary splits for travel distance described in Study 3.

The first ANOVA (gender x 0km versus >0km) on age found a significant main effect for travel distance, $F(1, 351) = 12.29$, $p = .001$, $\eta^2_p = .034$; i.e. offenders travelling to commit arson (i.e. >0) were significantly younger than offenders not travelling (see Table 9.23).

Table 9.23: Descriptive Statistics for Age at first offence by Gender and Travel Distance (0 vs >0 km split).

		N	Median	Mode	Mean (SD)	Percentage	Range
	Total	30	27.5	23*	30.33 (17.70)	8	59 (7 – 66)
0 km	Male	19	23	23	25.75 (16.99)	63	56 (7 – 63)
	Female	11	38	16*	38.27 (16.72)	37	50 (16 – 66)
	Total	325	15	14	20.44 (12.28)	92	61 (6 – 67)
>0 km	Male	282	15	14	19.54 (11.10)	87	57 (6 – 63)
	Female	43	16	13*	26.35 (17.25)	13	59 (8 – 67)

*Multiple modes exists. The smallest value is shown.

The usual significant main effect was found for gender, $F(1, 351) = 14.005$, $p < .0001$, $\eta^2_p = .038$; i.e. females were older at time of first offence than male offenders, but the interaction was not significant, $F(1, 351) = 1.225$, $p = .269$, $\eta^2_p = .003$.

The same results on age and travel distance as a binary variable, but split according to <5 km vs 5 km or more, are shown in Table 9.24. As usual, the ANOVA on age found a significant main effect for gender, $F(1, 351) = 14.18$, $p < .0001$, $\eta^2_p = .039$; females being older than male offenders, but in this case there was no significant main effect for travel distance, $F(1, 351) = 1.302$, $p = .255$, $\eta^2_p = .004$; and the interaction was not significant, $F(1, 351) = 3.233$, $p = .073$, $\eta^2_p = .009$.

The results in Table 9.24, therefore, present something of an anomaly. The overall rank correlation shows a general trend for those who travel further to be older in terms of age of first offence, but the first ANOVA shows that those who do not travel tend to be older than those who do. An examination of the mean and median ages in Tables 9.23 and 9.24 suggests a possible reason for this; i.e. in terms of mean and median totals, those oldest at the time of first offence tended to fall into the extreme categories (0 and > 5km).

Table 9.24: Descriptive Statistics for Age at first offence by Gender and Travel Distance (<5km≥5km split).

		<i>N</i>	Median	Mode	Mean (<i>SD</i>)	Percentage	Range
<5km	Total	245	14	14	19.79 (13.05)	69	61 (6 – 67)
	Male	208	14	14	18.12 (11.15)	85	57 (6 – 63)
	Female	37	20	14	29.19 (18.21)	15	55 (12– 67)
≥5km	Total	110	21.5	14	24.57 (12.62)	31	55 (8 – 63)
	Male	93	21	14	23.97 (11.67)	85	55 (8 – 63)
	Female	17	22	41	27.88 (16.94)	15	49 (8 – 57)

*Multiple modes exist. The smallest value is shown.

To investigate this further, therefore, the age data were split according to three categories of travel distance data, 0, >0-5, and ≥5 km, and a 3 x 2 (travel distance by gender) ANOVA on the age data was performed. The results are summarised in Table 9.25.

Table 9.25: Descriptive Statistics for Age at First Offence by Gender and Travel Distance (split into three levels)

		<i>N</i>	Median	Mode	Mean (<i>SD</i>)	Percentage	Range
Travel Distance: 0km	Total	30	27.5	23*	30.33 (17.70)	8	59 (7 – 66)
	Male	19	23	23	25.74 (16.99)	63	56 (7 – 63)
	Female	11	38	16*	38.27 (16.72)	37	50 (16 – 66)
Travel Distance: >0.00 - <5.00km	Total	215	14	14	18.32 (11.57)	61	61 (6 – 67)
	Male	189	14	14	17.35 (10.14)	88	47 (6 – 53)
	Female	26	14	14	25.35 (17.72)	12	55 (12 – 67)
Travel Distance: ≥5.00km	Total	110	21.5	14	24.57 (12.62)	31	55 (8 – 63)
	Male	93	21	14	23.97 (11.67)	85	55 (8 – 63)
	Female	17	22	41	27.88 (16.94)	15	49 (8 – 57)

*Multiple modes exist. The smallest value is show.

The ANOVA found a significant main effect for travel distance, $F(2,349) = 8.65, p < .0001, \eta^2_p = .047$. Post hoc LSD tests on the main effect for travel distance found that all groups differed significantly from each other ($p < .03$); i.e. those who did not travel at all were oldest, followed by those who travelled over 5km, whereas those who travelled an intermediate distance tended to be younger than both of the other groups. There was also the usual significant main effect for gender, $F(1,349) = 15.52, p < .0001, \eta^2_p = .043$, females being older than male offenders, but the interaction was not significant, $F(2,349) = 1.22, p = .269, \eta^2_p = .007$.

It is also interesting to note from the frequency data in Table 9.25 that, of the 355 offenders, 8% did not travel at all, whereas the majority, 61%, travelled between 0.00 km and 5km, and 31% travelled 5.00 km or more. However, when broken down according to gender, the standard gender (approximately 85% males to 15% females) ratio as seen in the general literature was evident in both the groups who travelled, but the proportion of females was higher in the subgroup who did not travel, where more female offenders were represented (37% females). Binomial tests within groups were all significant ($p < .0001$), but the difference in gender proportions was also significantly different between groups reflecting the greater female representation in the non-travelling group, $\chi^2(2) = 12.33, p < .002$. These results fit the findings reported earlier that being female is a significant risk factor for targeting one's own home and self.

Binary Logistic Regressions. To further explore the travel distance data two binary logistic regressions were run, as in Study 3, one with 0km versus >0km as the dependent variable, the other with <5 versus ≥ 5 km as the dependent variable, and the demographic and biographical variables as predictors (n.b. for the same reasons given in Study 3, it was not possible to use travel distance as a continuous variable and run a standard multiple linear regression). In this case, the research questions addressed were: what demographic and

biographical characteristics best predict a) whether offenders will or will not travel to commit offences, and b) whether offenders will travel longer distances to commit offences.

The BLR with Travel Distance split 0/>0 km as the dependent variable, and the demographic and biographical variables as predictors (see Table 9.26), significantly predicted 93% of cases, $\chi^2(18) = 44.25, p = .001$, and explained 27% of the variance (Nagelkerke $R^2 = .27$). Significant predictors of not travelling (as distinct from travelling away from home) were having a psychiatric history ($p = .007$) but not having a history of alcoholism ($p = .044$). The AUC value was .79 ($SE = .046$), $p < .0001$).

Table 9.26: Binary Logistic Regression with Travel Distance split 0/>0 km as the dependent variable, and the demographic and biographical variables as predictors

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(B)
Psychiatric History	-1.63	0.61	7.23	1	.007	0.20
Alcoholism History	1.16	0.58	4.07	1	.044	3.19

Interestingly, although there were significant differences between the travel and no travel groups in terms of age of first offence, age was not a significant predictor of travelling in the regression. A rerun of the regression showed that although age was, indeed, a significant predictor when entered by itself, it ceased to be significant when psychiatric history was entered in the regression. This suggests that one of the main reasons why age may be predictive of not travelling, is that those with a psychiatric history tend to be older (see Table 7.1), and offenders with a psychiatric history are more likely not to travel.

Given the higher ratio of females to males in the not traveling group, and that gender significantly predicted targeting oneself and one's own home, one might also have expected gender to predict not traveling; and, accordingly the zero-order association between being female and not travelling was actually significant, $\Phi = .18, p = .001$. However, a rerun of the regression showed that, although gender did significantly predict travelling when entered by

itself, it ceased to be a significant predictor when psychiatric history was entered. This suggests that, in this case, the presence of psychiatric history provides a better ‘all round’ prediction of why some offenders (and particularly females) tend not to travel, and gender relates to ‘not travelling’ primarily through its association with psychiatric history ($\Phi = .26, p < .0001$).

The BLR with Travel Distance split $\leq 5 / >5$ km as the dependent variable and the other offence related behavioural characteristics as the predictors (see Table 9.27) significantly predicted 74% of cases, $\chi^2 (18) = 73.93, p < .0001$, and explained 27% of the variance (Nagelkerkel $R^2 = .27$). Significant predictors of travelling longer distances (> 5 km) were: being a rural offender ($p < .0001$), being 18 or over at the time of first offence ($p = .021$), and not enrolled at school ($p = .036$). The AUC value was $.77 (SE = .026), p < .0001$.

Table 9.27: Binary Logistic Regression with Travel Distance split $\leq 5 / >5$ km as the dependent variable, and the demographic and biographical variables as predictors

	<i>B</i>	<i>SE</i>	Wald	Df	<i>p</i>	Exp(B)
Urban/rural	-1.21	0.31	15.24	1	.0001	0.30
Under/Over18	1.12	0.48	5.37	1	.021	3.06
School Pupil	-0.92	0.44	4.38	1	.036	0.40

The results for age here, are more in line with those for the ANOVA (those who travel further tended to be older at the time of first offence), though it is interesting to note that, with the other variables taken into consideration, a binary split <18 versus ≥ 18 provided a better prediction of travel distance than age of first offence as a continuous variable.

9.5. Discussion

Again the results of this study show some potentially interesting patterns of behaviour relating to targets, relationship with the victim, and crime scene behaviours, many of which

have not previously been investigated in the literature on arson. Additionally, a number could be construed as overlapping with the results of the previous study. The main findings can be summarised as follows.

9.5.1. Targets

As reported in Chapter 8 the most common target was a residential property, and there were three significant demographic predictors of targeting a residential property; gender, age and alcoholism. With regard to gender, most offenders were still male (75%), but females were proportionally more represented than males (59% and 25%, respectively); being female significantly predicted targeting residential properties. This fits with some previous research that females are more likely to set fire to their own property, or the property of someone they know (Bourget & Bradford, 1989; Burton et al., 2012; Harmon et al., 1985). Moreover, it has been argued that, rather than for insurance fraud or financial gain, the reasons for doing this may be more personal reflecting motives such as revenge, attention seeking behaviour or cries for help (Gannon, 2010; Rix, 1994; Trent, 1988). Being older was also a significant predictor, perhaps because those who set fires for insurance claims tend to be older (Inciardi, 1970), but also because those who own residential properties or have financial dealings, or relationship issues tend to be older. A history of alcoholism was also a significant predictor for targeting a residential property, which perhaps fits with previous findings that revenge arsonists tend to be loners and have alcohol problems (Inciardi, 1970; Wood, 1999).

There were only two significant demographic predictors of targeting a business; more likely to have convictions other than arson, and less likely to have a psychiatric history. In the previous study it was found that those who targeted businesses were less likely to target vehicles, but otherwise targeting of businesses was relatively discrete and showed non-significant negative trends as regards other targets. Taken together, these findings further

endorse the suggestion that those who target business properties might do so, more or less exclusively, for insurance fraud or other monetary gain, rather than personal motives.

Again, only two significant predictors were found for targeting a school; more likely to live with parents and less likely to be unemployed. Interestingly, although the zero-order Phi correlation showed that being younger at the time of first offence was significantly related to targeting a school ($\Phi = -.23, p < .0001$), age at the time of first offence was not a significant predictor in the final regression, suggesting that living with parents may be more important than age per se. Motives for setting fire to a school can be complex (Ekbrand & Uhnoo, 2014), though vandalism has been identified as a primary reason (Inciardi, 1970). One possible explanation for the present finding, might be the existence of a subgroup of young offenders who do not live at home and are more likely to be unemployed and more inclined to fire targets for revenge or financial gain; i.e. targets which would tend to exclude schools. This would also fit with the interpretation of the findings of the previous study which suggest that targeting schools may be more common amongst those seeking stimulation and excitement.

There were three significant demographic predictors of targeting a public building; more likely to come from an urban area, have a psychiatric history and less likely to have convictions other than arson. According to Burton et al. (2012), as the majority of public buildings tend to be in urban areas, it would naturally follow that coming from an urban area is a predictor for targeting a public building. However, an association between firing a public building and having a psychiatric history has not previously been identified in the literature. One possibility, also mentioned in the previous study, is that offenders with psychiatric problems, such as a fascination with fire (Canter and Fritzon, 1998), may target public buildings for maximum impact. However, an additional possibility is that individuals with psychiatric problems may, in daily life, be more dependent on services from staff in public

buildings. Given that mentally ill offenders often set fires due to revenge (Wood, 1999), they may target a public building if they consider that someone connected to an institution has wronged them.

Four significant demographic predictors of targeting a vehicle were found: more likely to be older at the time of the first offence, but less likely to be a school pupil, less likely have issues with alcohol and have a psychiatric history. Being both older at the time of the first offence, as well as less likely to be enrolled at school, suggests older offenders generally may be more likely to target vehicles. Together with the findings of fewer issues with alcohol and less likelihood of a psychiatric history, and as noted in regard to the previous study, this suggests that vehicle arson may be more of a calculated offence related to, for example, monetary gain or crime concealment.

There were three significant demographic predictors of targeting self; female gender, over 18 years old at the time of the first offence, and having been institutionalised. Of the 22 offenders (6%) who targeted themselves, 12 (55%) were female offenders and 10 (45%) were male offenders. In fact, this was the only category of offences where female offenders outnumbered males. According to the literature, arsonists are often placed outside the home (Kazdin & Kolko, 1986; Kolko & Kazdin, 1990), however, this seemed to be a particular risk factor for this group and for females in particular. One possibility is that, although both male and female fire-setters often come from dysfunctional homes (Sapp, Icové et al., 1994) it might be the case that female fire-setters react to the dysfunction in a different way compared to males, and are more likely to turn to self-harm. In general, suicide rates tend to be greater for males than females (Cantor & Neulinger, 2000; Shiner, Scourfield, Fincham & Langer, 2009). However, female arsonists may present a special case; for example, targeting oneself through arson may reflect a specific way of responding to a breakdown of established social

bonds especially amongst those who are older, and more vulnerable due to experiences of living in an institution (Shine et al., 2009).

Similarly, the two significant predictors for targeting own home were female gender and having been institutionalised. Although the majority of those targeting their own home were males (63%), proportionally, a gender ratio of 40% females compared to 12% male offenders was found, which again shows female offenders as over-represented compared to the standard gender ratio. As noted in the previous chapter, setting fire to one's own property could possibly suggest insurance fraud. However, in this case the significant predictors were female and having been institutionalised, which is more suggestive of a more personal motive such as revenge, which has been reportedly the most common motive for women carrying out arson (Bourget & Bradford, 1989; Lewis, & Yarnell, 1951; Scott, 1974; Scott, 1977). And, indeed, in this respect there is a possible overlap with the previous study which found a relationship between targeting one's own home and targeting an ex-partner, endangering lives and operating alone.

9.5.2. Relationship Variables

With regard to relationship variables, in the present study, there were two significant demographic predictors of targeting a victim known to the offender: more likely to have other convictions than arson, and to be older at the time of the first offence. In the literature it has been proposed that arsonists who know their victims are more likely to have a psychiatric history (Wood, 1999) and that females are more likely to set fire to property which belongs to people they know (Bourget & Bradford, 1989; Burton et al., 2012; Harmon et al., 1985). However, neither proposal was supported in the present results. In contrast, offenders who knew their victim were more likely to be older at the time of first offence and have previous convictions other than arson. In general, this might suggest that these offenders may be on a

criminal life path or a life path on the border of what is legal; i.e. deliberately seeking to endanger the lives of those they know through arson may reflect more general criminal tendencies in contrast to the standard younger offender looking simply for excitement and stimulation.

With regard to targeting an ex-partner, there was only one significant predictor, less likely to be unemployed; though being older at the time of first offence just narrowly missed being significant ($p = .052$). The finding regarding employment was unexpected; though one possibility is that offenders who target ex-partners who are older and employed are again more likely to be motivated by personal reasons, such as revenge or jealousy following a breakup, rather than more instrumental reasons such as financial gain or for excitement. As mentioned previously, some studies suggest that females are more likely to target someone they know, including partners and ex-partners (Bourget & Bradford, 1989; Burton et al., 2012; Harmon et al., 1985). However, being female was not a significant predictor for targeting an ex-partner.

There were three significant demographic predictors of prior violence towards victim; more likely to be rural and have a psychiatric history, and less likely to be living with parents. As noted in Chapter 3, although one might expect prior violence to victims to be more common in urban areas due to factors such as population density, lower economic status and possibly social disorganisation (Weisheit and Donnermeyer, 2000), results have been inconsistent. For example, Osgood and Chambers (2000) found that violence was as likely in rural areas. The reason why, in the present results, prior violence towards the victim was greater in rural in areas is therefore unclear. However, some research suggests that violence in urban and rural areas may have different profiles. For example, Logan, Walker, Cole, Ratliff and Leukefeld (2003) found that because rural women received less support, lower income, and were less educated than their urban counterparts, they might be more sensitive

and reactive to physical and sexual abuse. Similarly, Logan, Walker and Leukefeld (2001) found the profile of the rural male, with lower education, lower employment rate, and greater use of psychoactive medications, led to higher rates of arrests for domestic violence. Spencer and Bryant (2000) also found that both male and female students from rural areas were more at risk for dating violence. Such results suggest that violence in rural areas may be more often related to relationship issues, and arson may simply be another manifestation of this; i.e. particularly when rural arsonists target those they know, out of revenge, jealousy etc., they are more likely to have a history of violence towards them. Any such tendencies might also be exacerbated by the presence of mental illness (such as paranoia, and/or borderline personality disorder) which might then account for why psychiatric history was also a significant predictor in this regression. The finding that offenders who had shown prior violence towards the victim were less likely to be living with parents also potentially fits with this profile, as those not living with parents would tend to be older and more likely to have experienced long term relationship issues, including family dysfunction, as well as economic hardship.

9.5.3. Crime Scene Variables

With regard to crime scene variables, there were two significant demographic predictors of lives endangered; female gender and psychiatric history. With regard to gender, although the majority of those targeting their own home were male (70%), proportionally, the gender ratio was 69% females compared to 29% male offenders, which again shows female offenders as over-represented in this subgroup. There is nothing obvious in the literature to account for this, however, one possible explanation, may involve the association with psychiatric history. Contrary to some previous research (for example, Burton et al., 2012), Study 2 in the present thesis showed only a minority of offenders had a history of psychiatric problems. However,

significantly, psychiatric history in the present study was associated with endangering lives. This could have been for any number of reasons; for instance, perhaps mentally ill offenders might have stronger compulsions to hurt others who they perceive have offended them, or they might be less likely to consider the serious consequences of endangering lives. Whatever the case, also notable in Study 2, was that female arsonists were over-represented amongst those with a psychiatric history. As such, crimes of arson in the present sample fit the general trend for female criminal offenders to be three times more likely to have psychiatric problems (Department of Health, 2007). At the same time it is well known that many individuals with serious psychological problems do not seek help and go undetected, hence they have no recorded psychiatric history. It could be the case that, compared to males, the present data underestimates the number of female arsonists who have mental illness issues, and thus gender emerges by itself as an additional predictor of endangering lives.

Significant predictors for planning the fire-setting were: more likely to be White, younger at the time of the first offence, rural offenders, and less likely to be living in an institution, as well as with parents. Again there appears to be nothing in the current literature that would explain why planning was particularly related to being White, beyond the general finding, also shown in the present sample, that the large majority of arsonists (89% here) tend to be White (Santtila et al., 2003; Sapp, Hobert et al., 1994). One possibility is that non-Whites, especially those of more recent immigrant origin may have less knowledge of or access to planning resources; however, given the small numbers of non-Whites involved it is difficult to offer anything substantive by way of evidence.

The finding that offenders, who were younger at the time of their first offence, were more likely to plan their fire-setting, was also somewhat unexpected given the trend shown in Studies 1 and 2 for 'serious' offenders, in terms of being serial arsonists, to be older at the time of the offence. However, a further breakdown of the results showed that age at first

offence was not a significant predictor of planning when entered by itself (correspondingly the zero-order Phi association was not significant, $\Phi = .04, p = .45$), but rather it became significant (in terms of a negative association) when living with parents was added to the regression, Wald (1) = 5.90, $p = .015$. This suggests that living with parents may act as a 'suppressor variable' on the relationship between age of first offence and planning arson. Conger (1974) provides the most generally accepted definition of a suppressor variable as, 'a variable which increases the predictive validity of another variable (or set of variables) by its inclusion in a regression equation' (pp. 36-37). In the present example, and as shown in Study 2, the zero-order association age at first offence and living with parents was negative and significant, $\Phi = -.68, p < .0001$; in other words, those younger at the time of their first offence were more likely to be living with their parents. However, *not* living with parents was significantly associated with planning arson ($\Phi = -.20, p < .0001$). It appears, therefore, living with parents suppresses the effects of the association between age and planning ($\Phi = .091, p = .087$), until the former is taken into consideration or partialled out; i.e. it is offenders younger at the time of their first offence, but not living with their parents, who are most likely to plan their offences. Interestingly, the same effect was found for being in an institution. This was not a significant predictor of planning when entered into the regression by itself, Wald (1) = 0.39, $p = .53$), but became significant (in terms of a negative association) when living with parents was added, Wald (1) = 4.82, $p = .028$. Taken together, these results suggest that younger offenders, coded as neither living with parents nor institutionalised, and thus perhaps receiving little guidance or potential sanctions from authority figures, were most likely to plan their offences.

Rural offenders were also more likely to plan their fire-setting. Again, this finding does not appear previously to have been investigated or reported in the literature but it could

be argued that those in more remote locations might have less access to materials for fire-setting, and consequently more planning might be necessary to achieve their objectives.

Significant predictors of offending in a group were: more likely to have had previous arson convictions, and be a school pupil. Whereas predictors of solo offending were: more likely to have convictions for criminal damage, be rural offenders, have a psychiatric history, have been in trouble in school and to be older at the time of first offence. These findings broadly replicate those already identified and discussed in terms of zero-order associations in Study 2 (Chapter 7), except that rural offending emerged as an additional significant predictor of solo offending in the regression, and being female (as a predictor of solo offending) did not emerge significantly in the regression. The fact that solo offenders were more likely to operate in rural areas could be due to a number of factors including the availability and accessibility of peers. Further selective investigation of the regression showed that, as anticipated, being female significantly predicted solo offending when entered by itself, but it ceased to be significant when enrolled at school was added. Investigation of the zero-order Phi associations then showed that male offenders were significantly more likely to be enrolled at school than female offenders ($\Phi = .11, p = .04$); taken together, therefore, these results suggest that enrolment at school better accounts for the association between gender and group/solo offending than gender per se.

More puzzling, however, was the fact that previous convictions including arson were associated with solo offending in Study 2, whereas in the regression group offending significantly predicted previous convictions for arson. Further selective investigation of the regression showed that the main reason for this anomaly appeared to be that the association between solo offending and the various measures of previous convictions (with the exception of criminal damage) were rendered non-significant, and in the case of convictions for arson, reversed, when three key variables were added to the regression. So, for example, whereas

the variable of previous convictions for arson was associated with solo offending when entered into the regression by itself, $\beta = -.43$, Wald (1) = 3.64, $p = .056$, the direction was significantly reversed, such that group offending predicted previous convictions for arson, when enrolment at school, trouble at school and psychiatric history were added, $\beta = .72$, Wald (1) = 5.01, $p = .025$. Further investigation showed that there was no clear reason for this, rather it appeared to result from a somewhat complex interplay between the relative strengths of the associations between the four variables. The fact remains, that when data are available for school enrolment, trouble at school, and psychiatric history, previous convictions for arson may potentially be considered more of a risk factor for group, than solo offending.

Only one significant predictor was found for multiple items fired; offender less likely to be unemployed. The reason for this is unclear; though, as noted earlier, less likely to be unemployed was also the only predictor of targeting an ex-partner. To explain the latter, it was suggested that those who are employed may tend to be older and motivated by personal reasons, such as revenge or jealousy following a breakup. It could be the case, therefore, that firing multiple items captures something about the modus operandi of the more serious offender who is intent on having maximum impact on his or her target.

Indeed, the same variable is apparent as a predictor of setting fire to multiple sites, along with being female, and having been in trouble in school. Of the 75 offenders who used multiple fire sites 24% were female, whereas only 13% of those not firing multiple sites were female. Again, there appears to be nothing obvious in the literature to account for these results, but the findings reported above indicate that females are also more likely to target ex-partners, so, as in the case of firing multiple sites, we may again be picking up indicators of the more troubled and serious arsonist who is determined to have maximum impact on his or her target.

Demographic predictors of offenders using an accelerant were: more likely to have had previous convictions including arson and previous convictions excluding arson, and less likely to have a conviction for criminal damage, have been institutionalised, committed arson whilst enrolled at school, and had trouble at school, which added up to six significant predictors of offenders using accelerant. However, as noted earlier, there was no support for the hypothesis that those with a psychiatric history would be more likely to use an accelerant. Again there is nothing in the literature that obviously stands out by way of explanation. However, in the previous study, when used as a dependent variable, use of accelerants was also significantly predicted by targeting vehicles, offending in groups and not targeting oneself, targeting businesses, knowing the victim/s, and using multiple sites. It was argued that these could be construed more as indicators of a positive relationship between the use of accelerants and more general organised criminal activity. If so, it could be that the demographic variables reported here (i.e. previous convictions, being institutionalised, having trouble at school, less likely to be engaged in vandalism/criminal damage etc.) are also possible indicators of offenders more likely to be engaged in organised criminal activity.

Significant demographic predictors of bringing (relatively unplanned) materials to the crime scene were: being male, being younger at the time of first offence, less likely to have a conviction of criminal damage and less likely to be employed in manual work. Male offenders (53%) were proportionally more likely to bring materials to the scene than female offenders (28%) but both male ($M = 18.71$; $SD = 10.88$) and female offenders ($M = 18.13$; $SD = 9.65$) who brought materials to the crime scene tended to be younger at the time of first offence. Again, there is nothing obvious in the literature to account for this; however, in the previous study, when entered as a dependent variable, bringing more general (unplanned or relatively unplanned) fire-setting materials to the crime scene (which occurred in slightly more cases, i.e. 50%) appeared to be predicted by a range of factors, including multiple

targets (schools, public buildings, vehicles, and miscellaneous objects, but not self), planning the offence, and not using alcohol, as well as knowing the victim and operating as a group. It was argued that these also could be construed primarily as indicators of more planned and organised criminal activity as distinct from opportunistic offending or arson committed for more personal reasons. Therefore, it is possible that the demographic factors identified here, associated with bringing materials, could again be linked with those more likely to engage in organised criminal activity rather than vandalism/criminal damage or arson for personal reasons. If so, not being engaged in manual work might predict because the category would include those who are 'unemployed' in the conventional sense (i.e. their 'employment' is crime), as well as those employed in non-manual work who may have the knowledge and expertise to gain from targeting others, including organisations, for insurance purposes etc.

There were four significant demographic predictors of offenders alerting someone after or during fire-setting: more likely to have other convictions excluding arson, issues with alcoholism, coming from/operating in an urban environment and less likely to have a conviction for criminal damage. Once again, there are no obvious explanations in the literature for these findings; alcoholism, for example, tends to be associated with fire-setting behaviour in general (Eidsson, 2005; Geller, 2008; Sapp, Hobort et al., 1994). However, in the previous study, alerting was associated with residential and miscellaneous targets, multiple items fired and remained/returned, which were interpreted in terms of offenders trying to absolve themselves of responsibility (in the case of insurance fraud involving personal property, for example), limit damage effects, and/or offending for excitement or stimulation (see Inciadi, 1970; Lewis and Yarnell, 1951). It could be the case, therefore, that the demographic variables here are also indicators of those most likely to be involved in these kinds of behaviours (as distinct from say, organised criminal activity, or less purposeful vandalism/criminal damage). With regard to the association with urban offenders, another

possibility is simply that, in a rural environment, finding someone to alert may be more difficult if there are fewer neighbours or passers-by.

Offenders who remained at the crime scene after the fire-setting were more likely to be over 18 years old at the time of first offence ($M = 26.36$; $SD = 15.60$), have a psychiatric history and be less likely to have previous convictions including arson. Again nothing particular was found in the literature regarding remaining at the crime scene. However, in the previous study, significant predictors of remained/returned included not targeting schools, but targeting own home, endangering lives, and giving an alert; it was then argued that this pattern endorses the fact that giving an alert and staying or returning to the fire are characteristics not limited to 'excitement arsonists' (Inciadi, 1970; Lewis & Yarnell, 1951), but may also encompass characteristics of offenders who target residential properties for personal reasons, such as revenge, and/or fraud (because they are short of money etc.). As such, one might also expect such individuals to be older, have a psychiatric history, and not necessarily have a history of previous general offending (i.e. not career criminals).

Significant predictors of use of alcohol during fire-setting were: more likely to have a previous conviction for criminal damage, be a rural offender, be over 18 years of age at the time of first offence, and have a history of alcoholism. Additionally, they were less likely to have lived in an institution and have a psychiatric history. As noted, the hypothesis that those with a psychiatric history would be more likely use alcohol during fire-setting was not supported; indeed, the opposite was the case, in that those without a psychiatric history were significantly more likely use alcohol during fire-setting. In the previous study, significant predictors for alcohol use at the time of the crime were less likely to target schools and public buildings and to bring fire-setting materials to the crime scene, but more likely to target a vehicle, and operate alone, as well as know the victim and target an ex-partner. It was argued that these predictors might be indicative of a relationship between the use of alcohol and

dispute-related violence (Felson & Staff, 2010). If so, then perhaps the demographic profile is the same: i.e. the offender who uses alcohol is more likely to be an older individual, prone to situational outbursts against individuals in disputes and exacerbated by habitual alcohol use, rather than someone with a history of mental illness, and/or involved in organised crime. As noted previously, this may also fit the profile of many rural offenders; i.e. violence in rural offenders also tends to be more personal and dispute related (Logan et al., 2001; Logan et al., 2003).

9.5.4. Travel Distance

Finally, regarding travel distance, when analysed using ANOVA, a significant main effect was found for age such that offenders travelling to commit arson (i.e. >0 km) were significantly younger at time of first offence than offenders not travelling to set fires. Given that age of first offence is likely to be broadly related to other measures of age of offending (see Chapter 6), this would appear to contradict the hypothesis, based on the previous literature, that older offenders would tend travel the furthest (Fritzon, 2001; Phillips, 1980; Rhodes & Conly, 1981). This might be due to a number of factors; for example, in the previous study, the main predictors of not travelling at all were endangering lives and targeting one's own home, however, younger offenders do not necessarily own their own houses, and/or have fewer material possessions to lose if committing insurance fraud; they may also be less likely to have a long term domestic relationship histories that may culminate in acts of despair, attention seeking etc. (Fritzon, 2001).

Nevertheless, a further breakdown of the data showed a curvilinear effect for age at first offence and travel distance, indicating that those who did not travel at all were oldest, followed by those who travelled over 5 km, whereas those who travelled an intermediate distance tended to be younger than both of the other groups. By way of explanation, the

results of the present study also showed that another significant predictor of not travelling was having a psychiatric history, which could also encompass the older mentally ill fire-setter who might set fire to their own home. Interestingly, although age at first offence was a significant predictor of travel distance when entered by itself, it ceased to be a significant predictor when psychiatric history was entered in the regression. This suggests that one of the main reasons why age at first offence may be predictive of not travelling, is that those with a psychiatric history also tend to be older (see Table 7.1), and offenders with a psychiatric history are more likely not to travel. At the same time, if age at first offence and age at the time of committing most crimes are related, it might also make sense that age would be associated with longer travelling distances as older offenders would be more likely to have cars, and be prepared to travel longer distances to target specific areas and/or people.

The other significant predictor of not travelling was less likely to have a history of alcoholism, though the reasons for this are not obvious. However, a rerun of the regression showed that alcoholism was not predictive of travelling/not travelling when entered by itself but it became significant when psychiatric history was added to the regression (see Table 9.26). As alcoholism and psychiatric history were positively associated ($\Phi = .43, p < .0001$), this would suggest that, when considered together, having a psychiatric history but not a history of alcoholism makes offenders particularly at risk for firing targets that do not require travel. This may be because the motives of such offenders (despair, attention seeking, self-harm etc.) are more deliberated and less coloured by the influence of alcohol.

A standard frequency analysis also found that the proportion of females was higher in the subgroup who did not travel. These results would appear to fit with the findings reported earlier that females tend to be older at time of first offence and being female is a significant risk factor for targeting own home and self. However, as reported above, like age, gender did not show up as a predictor in the regression, but a rerun of the regression showed that it

ceased to be a significant predictor when, once again, psychiatric history was entered. This once again suggests that the presence of psychiatric history provides a better ‘all round’ prediction of why some offenders (and particularly females) tend not to travel.

In the regression analyses, as well as being older (over 18), other significant predictors of travelling longer distances (> 5km) were being a rural offender, and not enrolled at school. In the previous study, the main predictors of travelling over 5 km were less likely to target a school, but more likely to target a vehicle, plan the fire-setting and know the victim. This, along with being older at the time of first offence and not enrolled at school, could be construed as indicative of the more organised offender out to exact revenge on a particular person, and/or to conceal the evidence of another crime. For example, studies have shown longer travel distances are associated with higher profits from robbery (Capone & Nichols, 1975; Van Koppen & Jansen, 1998) and burglary (Snook, 2004), and that there is a trade-off between travel distance and attractiveness of the target (Bernasco, 2007). As such an arson offender travelling further than 5km might also find the target very attractive and, therefore be prepared to travel a longer distance. Also, as mentioned previously, older offenders, who are not enrolled at school, are also more likely to have cars.

The finding that being a rural offender increased the likelihood of travelling more than 5km was as predicted, and makes sense, given that targets tend to be sparser in rural areas and there are fewer obstacles to travel.

9.5.5. Conclusion

There appear to be a number of points of possible convergence between the findings of this and the previous study which invite speculation about which theoretical viewpoint or viewpoints might best represent the present findings. As before, one could perhaps argue that, although limited, Inciardi’s (1970) rather old (1970) classification of arson offenders as

‘revenge arsonists’, ‘excitement arsonists’, ‘insurance claim arsonists’, ‘vandalism offenders’ and ‘crime concealers’, seems perhaps to provide the most appropriate, if somewhat limited, way of describing some of the main patterns in the data. However, other possibilities, reviewed earlier, that partially overlap with Inciardi’s scheme, include Canter and Fritzon’s (1998) interacting themes or typological profiles based on inferred motives (instrumental or expressive) and the target (person or object). According to these themes, an offender who repeatedly targets other people as a form of revenge would be classified as ‘instrumental person’ motivated; a theme that might be applied in the present data to offenders who, for example, targeted residential properties, ex-partners and endangered lives. Similarly the young firesetter who sets fire opportunistically to buildings or for other criminal goals might be classified as ‘instrumental object’, a categorisation that might apply to young male arsonists in the present sample who committed arson for excitement or to pursue criminal goals such as fraud or concealment of theft. Furthermore, the subgroup of offenders who gave an alert or remained at the scene after setting fire to properties and miscellaneous objects and remained, might be considered to fit the ‘expressive object’ theme (fitting again the stereotype of Lewis and Yarnell’s (1951) and Inciardi’s (1970) ‘excitement arsonist’, who like setting or watching fires).

Another possible overlapping theoretical framework is that of Faulk (1994) who classified arson simply in terms of whether the offence was instrumentally motivated instrumentally, as means to an end (for instance, for financial gain, crime concealment, revenge, to relieve boredom, as a cry for help, to become a hero, to end one’s life, or to enhance self-esteem), or whether the offence was intrinsically motivated (for example, because of pyromaniac tendencies, sexual excitement, or affect regulation). However, whilst it could be argued that the instrumentally category encompasses those offenders in the present sample who might have set fires for financial gain, crime concealment, revenge or to

relieve boredom, the intrinsically motivated category seems less applicable. Hence although one could argue that affect regulation would cover the offenders with a psychiatric history, very few offenders seemed to fit the profile the sexually motivated offender. Moreover, the concept of a dysfunctional home environment, which may figure particularly with female offenders, is not an obvious feature of this scheme (or the schemes of Inciardi and Canter and Fritzon for that matter). Perhaps more fitting with the view that arson may be precipitated by a dysfunctional home environment is Functional Analysis Theory (Jackson, Glass & Hope, 1987; Sturmey, 2008); as mentioned earlier, this proposes that firesetting is facilitated and maintained via a complex interaction of previous circumstances and events, and psychosocial disadvantages, which can include, poor caregiver relationships, depression, and internal and external firesetting triggers. As a result, for example, children who experience significant social difficulties might be more likely to engage in firesetting behaviour, as it gives them some form of power, influence and acceptance from their peers that might otherwise be unobtainable due to their poor social repertoire and lack of attention from caregivers. As seen in the present sample, it was not uncommon for offenders to have been placed outside the home due to possible dysfunctional home environments; nevertheless, given the range of possible motives and arson related behaviours found in the present sample it seems that Functional Analysis Theory has little of substance to say about the motives and behaviours of the majority of offenders.

Given the various criticisms that have been voiced against these kinds of of typological approaches (Gannon & Pina, 2010; Goodwill et al., 2009), and as emphasised in the previous chapter (see also Chapter 5), the main purpose of the last two studies in this thesis was not to attempt to devise some kind of global theoretical structure to describe the results, but simply to gather as much summary data as possible about the individual variables from the information available, then to use this information to devise an item, or variable,

based system for capturing the data, which is described in the final General Discussion section of this thesis. In this respect, it is again notable that all of the regression models and their associated AUC values were significant, indicating that, as a general principle, it may be possible to predict particular offence related behaviours and characteristics from demographic and biographical characteristics in a statistically reliable way. Nevertheless, as in the last study, there were also clear differences between the various offences; different offence related characteristics were associated with different sets of demographic predictors; i.e. the characteristics of consistency and distinctiveness were again demonstrated for these data as they have been for other crimes (see Santilla, Fritzon & Tamelander, 2004; Woodhams & Toye, 2007). Also, as in the last study, to the best of the researcher's knowledge, the present studies are the first time that the method of using a series of regressions to predict individual arson offence characteristics from demographic and biographical variables has been employed in this respect (rather than statistically grouping characteristics through SSA or factor and principal components analysis).

However, in addition to simply summarising demographical, biographical and offence related characteristics of the arsonists sampled, and assessing relationships between them, another potentially useful way of examining the data is to investigate how well they may predict a single criterion that might have practical significance, such as the likelihood of future offending; hence this was the aim of the next study.

Chapter 10

Study 5 - Predicting Likelihood of Arson Recidivism from the Offence Related and Demographic and Biographical Variables: Serial Arson Revisited.

10.1. Introduction: Indicators of Arson Recidivism

The aim of the analyses in the brief study in this chapter is to attempt to estimate which variables from Studies 1- 4 are most likely to affect individual arson offending rates and, thereby, identify those individuals most likely to offend again. However, as actual recidivism was not measured in the present studies, an indirect or proxy measure was needed. In the present study, the measure chosen was *previous convictions for arson*; in effect then, this study revisits the variable of single versus serial arson offending, which is potentially one of the most important criteria in the study of arson for which it would be useful to identify risk factors.

The most obvious rationale for using previous convictions for arson as an indirect or proxy measure of future offending would be the familiar adage that the best single predictor of future behaviour is past behaviour, which has not only been widely supported in the general literature on individual differences (Michel, 1968), but also in the literature on criminal behaviour (Bonta, Law & Hanson, 1998; Edwards & Grace, 2014). Hence, Goodwill et al. (2009) used this as their criterion dependent variable to test the predictive validity of models of general offending. But, perhaps most important, previous convictions for arson came out as the strongest and most significant predictor of arson recidivism in Edwards and

Grace's (2014) regression study of 1250 arsonists in New Zealand (OR = 3.27). This fits with a variety of other findings indicating that the frequency of previous firesetting behaviour is the strongest predictor of future arsons (see, for example, Brett, 2004; Kennedy, Vale, Khan, and McAnaney; 2006; Quinsey et al., 1998; Rice & Harris, 1996; Sapsford et al., 1978).

In fact, in their study, Edwards and Grace (2014) found that only three demographic variables significantly predicted arson recidivism in their final stepwise model, and of these, previous convictions for arson was the most important; the other two were convictions for vandalism (i.e. criminal damage), and age of first offence, under 18 (those under 18 were more likely to reoffend). As criminal damage includes arson obviously it was not included by itself as a possible predictor variable in the following analyses. However, age of first offence as a predictor variable, presents something of a paradox.

As mentioned previously, a variety of research, including trends in the present findings, indicates that serial firesetters are more likely to be older at the time of their first offence (see, for example, Edwards & Grace, 2007; Sapp, Hobort et al., 1994; Stewart & Culver, 1982; Kennedy et al., 2006; Waschi et al., 2007). And, indeed, when Edwards and Grace (2014) considered age of first offence as a continuous variable, the zero order correlation showed a non-significant *positive* relationship with arson recidivism, and a significant positive correlation with recidivism for other offences; i.e. serial offenders tended to start their criminal careers when they were older. However, when considered as a dichotomous variable (<18, ≥18), those *under 18* were more likely to show recidivism for arson and other offences. Edwards and Grace offer no explanation for this anomaly and did not examine their data further to identify the possible influence of other variables on this finding in their stepwise model. In the present thesis, there was, in fact, no difference in the directions of the zero order relationships between age of first offence and previous convictions for arson using the two measures; i.e. whether age of first offence was measured

as a continuous or binary (<18 , ≥ 18) variables; in both cases ($n = 355$) those with previous convictions started offending later ($r_{pb} = .22$, $p < .0001$; $\Phi = .28$, $p < .0001$, respectively). Nevertheless, given these considerations, as in Study 4, in addition to age as a continuous variable, age as a binary variable (<18 , ≥ 18) was included as a possible predictor in the analyses in the present study (n.b. as noted in Chapter 9, both predictors were applied simultaneously in Edwards and Grace's study).

Accordingly, a multiple logistic regression analysis was conducted on the demographic and biographical variables investigated in Studies 1 to 4 for the $n = 355$ sample, but specifically with *previous convictions for arson* as the criterion or dependent variable.

10.2. Method

The rationale for using binary logistic regression in this context is given in Chapter 5. As explained in Chapter 5, and also noted in Chapter 8, given there is now a growing consensus among statisticians that stepwise procedures are invalid, a standard forced entry method was used (Studenmund, & Cassidy, 1987) followed by consideration of significant predictors. Also as recommended by a number of researchers in the area, again AUC (area under the ROC curve) statistics were generated as a measure of overall predictive accuracy (Edwards & Grace, 2014; Goodwill et al., 2009; Rice & Harris, 1995).

As before, the coding system used by Goodwill et al. (2009) was applied; i.e. offenders were coded 1 if they had previous convictions for arson, and 0 if they had none.

10.3. Results

10.3.1. Demographic and Biographical Variables

The results for the forced entry procedure with previous convictions for arson as the dependent variable, and demographic and biographical variables as the predictors are shown

in Table 10.1. The zero order associations between previous arson convictions and the main demographic and biographical variables ($n = 355$) are reported in Study 2 (Chapter 7).

Table 10.1: Demographic and Biographical Predictors of Previous Convictions for Arson (significant predictors in bold).

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(B)
Convictions Excluding Arson	1.48	0.31	23.49	1	.0001	4.39
Rural/Urban	0.99	0.33	9.35	1	.002	2.70
Gender	1.36	0.48	7.94	1	.005	3.91
Enrolled at School	-1.10	0.44	6.28	1	.012	0.34
Manual Work	-1.18	0.53	4.92	1	.027	0.31
Nationality	-1.44	0.76	3.59	1	.058	0.24
Psychiatric History	0.68	0.44	2.38	1	.123	1.97
Ethnicity	1.31	0.87	2.28	1	.131	3.69
Unemployed	-0.56	0.40	1.93	1	.165	0.57
School Trouble History	0.44	0.41	1.14	1	.285	1.55
Under/Over18	0.38	0.54	0.49	1	.485	1.46
Age	-0.01	0.017	0.30	1	.585	0.99
Alcoholism History	0.20	0.39	0.27	1	.606	1.22
Living with Parents	-0.20	0.49	0.17	1	.678	0.82
Living in Institution	0.20	0.50	0.15	1	.695	1.22
Constant	-2.21	1.03	4.58	1	.032	0.11

The model significantly predicted 78% of cases, $\chi^2(15) = 105.12, p < .0001$, and explained 37% of the variance (Nagelkerke $R^2 = .37$). The AUC was classed as excellent and highly significant, .83 ($SE = .023$), $p < .0001$. Significant predictors of previous convictions for arson were: having convictions excluding arson ($p < .0001$), coming from an urban area ($p = .002$), and being male ($p = .005$); but not enrolled at school ($p = .012$), and not doing manual work (.027). Being of non-Danish nationality also approached significance ($p < .058$). Of all the predictors, previous convictions other than arson was the greatest risk factor (OR = 4.39), followed by male gender (OR = 3.91) and not enrolled at school (1/Exp(B) OR = 2.94).

It can be noted that, in this regression, neither age of first offence as a continuous variable nor as a binary classification significantly predicted previous convictions for arson, and the results were unaffected by the exclusion of one or the other from the regression.

10.3.2. Offence Related Behavioural Variables

The zero order associations (Phi and point biserial correlations) between arson convictions and the offence related behavioural variables are shown in Table 10.2.

Table 10.2: Zero Order Associations (Phi and Point Biserial Correlations) between Previous Convictions for Arson and Offence Related Behaviours (*p* values in second row)

Resid- ential	Busin- ess	School	PubBlg	Vehicle	Miscell	Self	Own Home	Victim Known	Ex- Partner	Prior Violence	
.012	.032	.058	.049	.185**	-.120*	.047	.023	.070	.064	.151**	
.826	.544	.273	.361	.0001	.023	.379	.663	.189	.227	.004	
Prior Threat	Lives Endang	Multi- Items	Plann- ed	Solo/ Group	Multi- Sites	Accel- erant	Material Brought	Alert Given	Remain/ Return	Alcohol Use	Travel Dist
.003	.053	.107*	.069	-.102	.136*	.148**	.055	-.064	-.010	.110*	.012
.951	.315	.045	.192	.056	.010	.005	.298	.229	.858	.039	.820

The BLR results for the forced entry procedure with previous convictions for arson as the dependent variable, and offence related behavioural variables are shown in Table 10.3. The model significantly predicted 75% of cases, $\chi^2(23) = 39.79, p = .016$, but only explained 15% of the variance (Nagelkerkel $R^2 = .15$). Although six variables predicted previous convictions for arson at the zero-order level (Table 10.2), the regression found only one significant predictor of previous convictions for arson when all variables were taken into consideration; i.e. targeting a vehicle ($p < .021$; OR = 2.88); though being a solo offender approached significance ($p = .079$; OR 1/Exp(B) = 1.75).

The AUC was significant but would be classed as ‘poor’, .70 ($SE = .031$), $p < .0001$.

Indeed, as evidenced by the 95% confidence intervals, this AUC (.64-.76) was significantly poorer than that for the demographic variables (.78-.88)

Table 10.3: Offence Related Behavioural Predictors of Previous Convictions for Arson (significant predictors in bold).

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(B)
Target Vehicle	1.06	0.45	5.59	1	.018	2.88
Solo/Group	-0.57	0.32	3.09	1	.079	0.57
Prior Violence to Victim	0.55	0.41	1.87	1	.171	1.73
Target Business	0.67	0.51	1.75	1	.186	1.96
Accelerant Used	0.37	0.33	1.25	1	.263	1.44
Multiple Sites Fired	0.37	0.36	1.08	1	.299	1.45
Multiple Items Fired	0.46	0.48	0.92	1	.338	1.59
Alcohol Use	0.28	0.30	0.91	1	.340	1.33
Target School	0.39	0.42	0.87	1	.350	1.48
Target Self	0.48	0.61	0.61	1	.434	1.62
Planned	0.21	0.31	0.47	1	.494	1.24
Travel Distance	-0.002	0.004	0.31	1	.579	1.00
Victim Known	0.20	0.37	0.30	1	.586	1.22
Target Public Building	0.23	0.47	0.23	1	.629	1.25
Alert After/During Fire	-0.16	0.34	0.21	1	.645	0.86
Remained/Returned	-0.13	0.34	0.15	1	.701	0.88
Lives Endangered	0.090	0.38	0.057	1	.811	1.09
Prior Threats to Victim	0.081	0.42	0.038	1	.846	1.09
Victim Ex-Partner	0.066	0.59	0.013	1	.911	1.07
Material Brought	-0.021	0.34	0.004	1	.951	0.98
Target Residential	-0.028	0.47	0.003	1	.953	0.97
Target Own Home	-0.024	0.47	0.002	1	.960	0.98
Target Miscellaneous	0.0001	0.45	0.0001	1	1.000	1.00
Constant	-1.720	0.49	12.13	1	.0001	0.18

10.3.3. Hierarchical Logistic Regression: Combining Variables

Given that the demographic and biographical variables appeared to predict convictions for arson better than offence related behaviours on all model measures including AUC values,

the next analysis involved performing a hierarchical logistic regression to see whether adding the offence related behaviours to the demographic and biographical variables improved the predictive accuracy of the former.

The results of the hierarchical logistic regression showed that adding the offence related behaviours very marginally improved the prediction of cases, from 78% to 79%, and the proportion of the variance explained improved from 37% to 44% (Nagelkerkel $R^2 = .44$), but overall the improvement was non significant, $\chi^2(23) = 39.79, p = .341$. The AUC was .86, ($SE = .020$; $CI = .82-.90$), $p < .0001$, which is only a very marginal improvement on that for demographic predictors alone (.83; $CI = .78-.88$).

10.3.4. Reduced Model

Notwithstanding this, however, it is interesting to note that a regression model based on manual entry of the six significant predictors ($p < .05$) from both sets of variables (i.e. not computerised stepwise regression) performed nearly as well as the full range of variables; i.e. the model significantly predicted 78% of cases, $\chi^2(6) = 93.81, p < .0001$, and explained 33% of the variance (Nagelkerkel $R^2 = .33$).

Overall, the two main risk factors were no history of offending while being enrolled at school ($1/\text{Exp}(B)$ OR = 5.00), having a history of convictions excluding arson (OR = 4.88). Furthermore, the zero-order association gender and school enrolment was significant, $\Phi = .11, p = .04$; in other words, in general, male arsonists were more likely to be enrolled in school. However, although not initially significant in the regression gender did become significant, when 'enrolled at school' was added. This suggests that school enrolment may act as a suppressor variable on the relationship between gender and serial offending. It appeared that, being enrolled in school suppresses the effects of the association between gender (i.e. being male as a risk factor) and previous convictions ($\Phi = .091, p = .087$), until the former is

taken into consideration or partialled out (partial $\Phi = .14, p = .009$); i.e. it is male offenders who are not at school who are at greatest risk for serial offending. Altogether, it suggests that particular risk factors were; being male, an urban offender, having convictions excluding arson, not being enrolled in school and not doing manual work at the time of offending. Notably, however, the one significant predictor amongst the offence related behaviours, Target Vehicle, failed to remain significant ($p = .11$) when entered in this analysis with the demographic and biographical predictors.

The AUC was also classed as excellent and highly statistically significant, .82 ($SE = .025$), $p < .0001$. Moreover, the 95% confidence intervals ($CI = .77-.86$) showed there was a significant difference between this AUC and the AUC for the offence characteristics alone ($CI = .64-.76$), and also there was a substantial overlap with those for the demographic ($CI = .78-.88$) and hierarchical analyses which combined both demographic and offence related characteristics ($CI = .82-.90$).

Table 10.4: Predictors of Previous Convictions for Arson: Reduced Model

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(<i>B</i>)
Convictions Excluding Arson	1.59	0.28	31.64	1	.0001	4.88
Enrolled at School	-1.60	0.30	28.42	1	.0001	0.20
Rural/Urban	0.71	0.29	5.98	1	.014	2.04
Gender	0.88	0.43	4.28	1	.039	2.41
Manual Work	-0.70	0.38	3.27	1	.071	0.50
Target Vehicle	0.56	0.34	2.62	1	.106	1.74
Constant	-1.94	0.45	18.78	1	.0001	0.14

10.4. Discussion and Conclusion

If at all generalizable, the results of this study may potentially have implications for understanding both serial arson and recidivism. Broadly speaking, the results show that demographic factors tend to be the best predictors of previous convictions for arson, and in particular, being male, an urban offender, having convictions excluding arson, not being

enrolled in school and not doing manual work at the time of offending. The offence related characteristics added little in understanding risk factors other than that serial arsonists were more likely to target vehicles. And, even then, this failed to remain significant when entered into a model together with the demographic and biographical factors. Together, however, in terms of the AUC value, the significant variables from both analyses provided an ‘excellent’ predictive model of previous convictions for arson according to Hosmer and Lemeshow’s (2005) classification that outperformed that for the offence related characteristics alone and showed more or less equivalent performance to the models containing the full range of variables (even though standard stepwise computation procedures were not used).

The fact that previous convictions excluding arson was one of the strongest predictors of previous arson convictions was expected given the results of Study 2, and this finding fits with the available literature on serial arson and arson recidivism (see, for example, Edwards & Grace, 2014; Sapp, Hobert et al., 1994). Also, as noted previously, the influence of gender as a risk factor (i.e. males are more likely to have previous convictions for arson and to reoffend) is fairly well established in the literature (Kennedy et al., 2006), though there are exceptions (Stewart, 1993; Stewart & Kazdin, 1994); notably also, in Edwards and Grace’s (2014) study there were so few females in the sample that gender was not considered. The present results appear to endorse the view that being male is a particular risk factor for serial arson and thereby, potentially, arson recidivism. Interestingly, however, there were no gender differences between single and serial offenders in Study 1 in the present thesis; and, indeed, when entered on its own into the regression in the present study, gender was not significant. In the present study, however, gender did become significant, when ‘enrolled at school’ was added to the regression. This suggests that school enrolment may act as a suppressor variable on the relationship between gender and serial offending. In the present example, the zero-order association gender and school enrolment was significant, $\Phi = .11$, $p = .04$; in other

words, in general, male arsonists were more likely to be enrolled in school. However, as also shown in Study 2 (see Table 7.10), *not* being enrolled in school was a significant predictor for serial arson ($\Phi = -.35, p < .0001$). It appears, therefore, being enrolled in school suppresses the effects of the association between gender (i.e. being male as a risk factor) and previous convictions ($\Phi = .091, p = .087$), until the former is taken into consideration or partialled out (partial $\Phi = .14, p = .009$); i.e. it is male offenders who are not at school who are at greatest risk for serial offending.

A similar effect was found for urban/rural; being an urban offender was not significant as a predictor of previous convictions for arson when entered into the regression by itself (see also Table 7.10 from Study 2), but became significant when ‘enrolled at school’ was entered in the present study; again this occurred because the relationship between being an urban offender and school enrolment was significant and positive ($\Phi = .11, p = .045$), whereas that between school enrolment and previous convictions was significant and negative (see $\Phi = -.35, p < .0001$); this had the effect of ‘cancelling out’ the relationship between urban/rural and previous convictions until partialled out in the regression. Put another way, these results suggest that, like male offenders, urban offenders who are not enrolled at school may be particularly at risk for serial offending.

The failure of age of first offence to emerge as a significant predictor may also be particularly important given the inconsistencies that have occurred in the literature. As mentioned previously, results have varied widely, sometimes depending on the actual age measure used (continuous or binary split). Hence a number of studies have reported that serial arsonists and arson recidivists tend to be older at time of first offence (Kennedy, 2006; Slavkin, 2001; Stewart & Culver, 1982); however, Edwards and Grace (2014) found that recidivists were younger and Kolko and Kazdin (1992) found no difference according to age. In Study 1 here, when included as a factor in a three way ANOVA, there was only a non-

significant trend for serial arsonists (both male and female) to be older at the time of first offence; however, the zero-order Phi coefficients reported earlier in this chapter showed significant positive associations between age and serial offending. To investigate this issue further, therefore, the regression was also rerun starting with age only as the predictor; as expected, the results showed that, by itself, age was significant as a predictor (serial offenders were older at time of first offence). However, again when ‘Enrolled at School’ was again added to the model, this time, age quite dramatically ceased to be significant, Wald (1) = .15, $p = .70$. To further illustrate this effect, it is informative to examine the frequencies for previous arson convictions by enrolled at school for offenders whose first offence occurred when they were of ‘school age’; i.e. under 18 years (see Table 10.3).

Table 10.5: Previous Arson Convictions by Enrolled at School for age of first offence <18 years.

	Not in school	In school	Total
No Arson Convictions	15 (52%)	158 (87%)	173 (82%)
Previous Arson Convictions	14 (48%)	23 (12%)	37 (18%)
Total	29 (14%)	181 (86%)	210

As can be seen in Table 10.3, for those offenders enrolled at school, only a small minority (12%) had previous convictions for arson. However, for those not enrolled at school, nearly half (48%) had previous convictions for arson; the difference in the proportions was highly significant, $\Phi = -.32, p < .0001$. These results suggest that not attending school may carry a considerably greater risk for serial convictions for arson than age of first offence per se.

Similarly, as might be expected from the zero-order Phi-coefficients in Chapter 7 (Table 7.10), not living with parents, employed and having a psychiatric history were all

significant predictors of previous convictions for arson, when entered by themselves; however, again, each ceased to be significant when ‘enrolled at school’ (with a negative beta value) was entered into the regression. Taken together, therefore, these results strongly suggest that ‘not being enrolled with school when committing an arson offence’ may perhaps be one of the best ways of capturing a range of variables that may related to serial offending; indeed, as mentioned, together history of convictions excluding arson, it emerged as the main risk factor for serial offending. It is very notable in this respect, therefore, that ‘enrolled at school’ is rarely, if at all, considered at all considered as a variable in studies of serial arson and recidivism, even with children and adolescents (see, for example, the review of arson in young offenders by Kennedy et al., 2006); and failure to consider this variable could possibly account for some of the inconsistencies in the literature related to gender and age, in particular.

However, on first consideration, the appearance of ‘manual work’ with a negative beta value (i.e. not a manual worker) as a predictor was more puzzling. When entered in the regression by itself, manual work was not a significant predictor, and correspondingly the zero-order association between this variable and previous convictions was positive and clearly not significant ($\Phi = .04, p = .43$). However, further investigation by selectively entering additional variables indicated that two, in particular, seemed to be most responsible for the suppression of the ‘not involved in manual work’ effect; these were ‘not enrolled at school’ again, but also ‘employed’. When added to the regression these two clearly turned the ‘manual work’ beta value to a negative sign. In other words it seems that, in combination with these other variables, ‘not involved in manual work’ may be picking up a category of offenders who may be particularly predisposed to serial offending, and are characterised by not being enrolled school, and being employed, but not as a manual workers; indeed, one is perhaps reminded again of Murphy and Maneval’s (1978) comment that arson for fraud is the

only organised white collar crime that is precipitated by a violent offence. Unfortunately, however, as mentioned in Chapter 7, there were insufficient data to accurately identify the employment status of the majority of those offenders who were employed, but this result suggests that this may be a useful avenue for future research.

Of the offence related characteristics, targeting a vehicle emerged as the only significant predictor of serial arson offending. The reasons for this are not immediately obvious, as to the best of this researcher's knowledge, vehicle attacks have not been the subject of much scientific inquiry; however, as shown in Chapters 8 and 9 of the present study, among the predictors of targeting a vehicle were use of accelerants, and not being enrolled at school; both factors which, as reflected also in their respective zero order associations, one might associate with offenders who are likely to engage in serious repeat offending, rather than a 'one off', spontaneous or opportunist attacks. Also, as mentioned earlier, although not looking at vehicle arson specifically, Edwards and Grace (2014) did identify various forms of vandalism or criminal damage, which would include vehicle arson, as one of their main predictors of arson recidivism. Notably, however, in the present study, even Target Vehicle failed to remain significant when the effects of the demographic and biographical variables were taken into consideration; though further selective inclusion of predictors indicated that none of the demographic and biographical predictors in itself was most responsible for cancelling out the influence of targeting a vehicle.

To sum up, assuming the present results have any generality, perhaps the major lesson to be gained is that, when attempting to identify the main risk factors for serial arson and, thereby, potential arson recidivism, as well as considering previous criminal convictions, it is important to take into consideration the influence of some very obvious demographic variables, these include employment status, and urban/rural location, but potentially most important, whether the offender committed arson while not enrolled at school. Not only

might this latter variable illuminate how other major contenders such as gender and age relate to serial offending in different samples, it may potentially outperform them as a predictor or risk factor. They also potentially indicate that, in general, demographic and biographical variables may be considerably more useful in predicting serial arson and potential arson recidivism than offence related or crime scene variables.

Chapter 11

Study 6 – Environmental Aspects of Arson

11.1. Introduction

11.1.1. Background

In the previous studies the primary emphasis was on the demographic and biographical characteristics and offence related behaviour of offenders. In this study (Study 6), the aim was to establish the relative influence of, and possible interactions between, a number of additional environmental variables on arson rates. The rationale for using these environmental variables was described in Chapter 3, and the primary emphasis was on items derived from Defensible Space Theory, CPTED (Crime Prevention Through Environmental Design) and Incivility Theory. As previously mentioned in Chapter 3 a different definition of urban and rural was used in Study 6. The reason for this was that one possible way forward would be to use an approach that would allow for studying the finer environmental details, as in the literature it has been stated that smaller research areas are recommended (Curtis & Rees Jones, 1998).

Accordingly, variables investigated included a number of those hypothesised to influence arson rates, such as the presence or absence of territorial markers (Abdullah et al., 2012; Bell et al., 1996; Bennett & Wright, 1984; Brown & Altman, 1983; Crowe, 2000; Donnelly, 2010; Newman, 1972; Newman, 1996), general maintenance of a neighbourhood (Crowe, 2000; Wilson & Kelling, 1982), graffiti (Wilson & Kelling, 1982), degree of surveillance, parking arrangements, presence of commercial/industrial areas, vacant

buildings, high rise buildings, types of housing, buildings with entertainment and public buildings (Bennett et al., 1987; Newman, 1972, 1996), distance to the nearest police station (Crowe, 2000; Newman, 1972; 1996) and population density (Agnew, 1999; Coleman, 1990; Wirth, 1938). In addition, an urban/rural comparison was again made. With regard to the latter, some studies have found more crime generally in urban areas (Ladbrook, 1988; NCVRW, 2013; Weisheit, Falcone & Wells, 1999) though a thorough investigation of this, in relation to arson, has yet to be carried out.

11.1.2. Approach

To investigate this range of variables, a variety of assessment methods were considered. In this respect, Dunstan et al.'s (2005) study on environmental features affecting residential satisfaction, proved useful. Dunstan et al. (2005) used a survey method, which was deemed inappropriate in the present context due to factors including problems of response rate, as well as general issues of accuracy and reliability. However, Dunstan et al.'s REAT (Residential Environmental Assessment Tool) categorisation was used as a broad basis for dividing up the variables. Hence the variables were grouped into two main clusters.

The first group of variables related to the individual properties; these were graffiti on property, maintenance of property, fences and hedges or borders around the property, surveillance from property, and of entrance, parking in relation to the main entrance and territorial markers on the property. The second group of variables related to the unit in which the properties were located. These encompassed if the unit was located in an urban or rural area, its population density, building density, level of maintenance, and litter. Additionally, consideration was given to whether the unit included high rise buildings, terrace houses, territorial markers, commercial properties, vacant buildings, public buildings, entertainment

buildings/areas, and the units' proximity to industrial areas and distance to nearest police station.

11.2. Hypotheses

Again, although much of the following analysis was exploratory, it was possible to derive some key hypotheses from the relevant literature regarding the chosen variables (see Chapters 3 and 4). These were as follows.

1. Areas with low maintenance, fewer surveillance options, graffiti and few territorial markers will have higher arson rates compared to those with opposite characteristics.
2. Areas with higher population and building density will have higher arson rates; and accordingly, urban areas will tend to have higher arson rates than rural areas.
3. Areas that are close to industrial, commercial and entertainment buildings/areas and contain high rise buildings and terrace housing, will have higher arson rates. Also, areas close to a police station will have a lower arson rates than areas further away from a police station.

11.3. Methods

11.3.1. Data Collection: Google Earth

The primary data for this study were collected from Google Earth Street View over a period of two years by two researchers. Google Earth is a virtual globe, map and geographical information program; it maps the earth by the superimposition of images obtained from satellite imagery and aerial photography. The data from Google Earth Street View were collected solely from the two Danish police districts described in Chapter 5: i.e. the Middle and Western Jutland Police District and the Copenhagen Western Police District. As mentioned in Chapter 5, these two police districts were selected to provide an overall representation of Denmark in relation to population density, rural and urban settings, crime

rates and architectural diversity as well as industrial and residential areas. The selection process involved first a detailed exploration of each area to create an overall view with regard to the variables to be investigated. Second, locations within the two police districts were selected in terms of how well they represented diversity in the variables under investigation; for example, variations or ratios in terms of architectural set up, structure of street grids, highrise/terrace house/bungalow, population clusters/nature, proportion of commercial buildings and industrial areas, and so on. The selected locations were scattered over the main part of the individual police districts, but in strategically specified areas to make sure the characteristics of the overall area were captured and represented in the created units (to be explained shortly). Although the available Google Earth Street View photos sometimes varied in terms of the dates when they were taken (for example, some photos were taken in 2013, and some in 2015), it was considered unlikely that this would have systematically affected the overall results.

11.3.2. Creating Units

To enable a framework for describing the data, the data (the selected locations) were divided into small units in the two police districts by the researcher. A number of researchers have suggested that smaller units of this kind may provide more ecologically valid results (Curtis & Rees Jones, 1998). At first, postcodes were considered as a possible way of creating units but postcodes cover some very large areas of land in Denmark and hence were considered to be too broad a measure. Instead, the aim was to create units that would, on average, be of a size to contain around 30 buildings, so the unit was not too large, but not too small either. In the event, as certain units within the capital area, had very high building density (6% of the units had between 100 and 337 buildings), the mean number of buildings in the units was 43.66 ($SD = 34.36$), though the mode was 30 buildings per unit (range 0 – 337).

In terms of unit borders, *natural* borders were used as far as possible. In other words, the researcher looked for features that would seem to denote the presence of a defined or coherent community and habitat. For example, a unit was considered to have a natural border if collections of houses seemed clearly divided by certain streets, or they had a set of closed high rise buildings or terrace houses facing each other or were in other ways joined, to create a communal border. This resulted in 294 units in total spread out over roughly 9.882km².

Particular place marks were put on Google Earth Street View outputs at each end of a unit to mark the beginning and end of a unit, and afterwards an image overlay was placed over each unit to mark the exact research area and the borders of each unit to be examined (see Appendix 7). Likewise, unique placemarks were placed on subgroups of buildings, such as for example commercial properties, public buildings, entertainment, etc. This was done to create an easy overview over proportions of certain buildings to make sure each subgroup was represented to the correct level for the individual location in the final analysis. For a property to be assessed, all of it had to be inside the defined borders of the image overlay marking the research unit. Additionally two different symbols were placed on the buildings in the research units: one symbol for buildings to be assessed and another symbol for buildings not to be assessed. All indicators for a unit (place markers, image overlays, symbols for assessable buildings, and symbols for non-assessable buildings, symbols for a diverse subgroups of buildings), were created in the same colour for each unit. The initial exploration of the police districts, the selection of the locations, the selection of the units, as well as placing the unit overlay and the diverse set of placemarks was done solely by the researcher over a period of roughly nine months.

As mentioned, some predictor variables were based on observations from individual properties. For example, the fences and hedges around the property or the level of surveillance from property, whereas other variables are based on the units as a whole, for

example litter in the streets, number of vacant buildings in the unit and distance to nearest police station. Finally, some variables are measured at both a unit level and an individual property level, such as maintenance and markers. However, due to accessibility on Google Earth Street View (i.e. level of identifiable detail), it was not always possible to score all individual properties on some of the variables. Hence, although every unit is represented with a score on all unit related variables, not every individual property is represented with a score on the property related variables. As a result, unit variable data were available for all 294 units, but individual property data were available for only 237 units.

11.3.3. Property Variables

Where possible, each property within a unit was measured on each of the property variables on a three point Likert scale, scored to indicate the presence or absence of features likely to increase arson rates according to the hypotheses; i.e. 0.0 indicating absent, 0.5 a moderate level, and 1.0 a high level. However, as the various units contained different numbers of properties, it was necessary to employ a measure of central tendency to summarize the scores for each unit such that each unit could be assigned a single score on each of the variables. Preliminary analyses showed that mode and median were insufficiently discriminating and the most sensitive way of doing this was to use the mean. It can be noted that, in the case of Likert ratings, the mean of the ratings within the group can be considered equivalent to the concept of mean rank, which is commonly applied in psychology as a measure of central tendency for ranks (see, for example, McDonald, 2009; Woodworth & Schlosberg, 1950). The individual property variables were as follows (For a summary of the codings of variables used in this chapter see Appendix 8 and Appendix 9).

Graffiti: Graffiti was defined as writing or drawings scribbled, scratched, or sprayed on a wall of a private property. On some buildings graffiti was allowed and hence was not

given a score. For example, on day care institutions for children, graffiti is often used on the wall to decorate the building. On the three point Likert scale a score of 1.0 indicated a high level of graffiti, 0.5 a small amount of graffiti and 0.0, no graffiti.

Maintenance Property: Maintenance was defined as the condition or the state of the property. A score of 1.0 indicated clear indications that the building was not cared for: for example, damaged brickwork, rotting woodwork, paint peeling off the walls, moss on roof tiles, garden tools, boxes, and toys spread over the ground; 0.5 was awarded for some indications of poor maintenance, and 0.0 if the property appeared well maintained. If the property was being rebuilt or refurbished it was not scored as exhibiting lack of maintenance.

Fences and Hedges: Fences and hedges were defined as any barrier, railing, or other upright structure (typically wood, wire, bushes or hedges), including symbolic barriers such as rows of stones or flowers, enclosing or demarking a private area. A score of 1.0 was given if no such barrier or border was present, 0.5 if a few barriers were present, and 0.0 if there were a number of clearly defined barriers.

Territorial Markers: Territorial markers were defined in the same way as for the unit variables mentioned in the next section. However, here they were applied to individual properties rather than characteristics of the unit as a whole. So, in accordance with the literature (see Chapter 3), territorial markers were defined as those items which made the property stand out as belonging to, or have significance for, certain individuals, such as personalised signs, benches, indications of a dog guarding the property and unique or special items, such as statues, or personalised plant displays. A score of 1.0 was given to a property with no territorial markers, a score of 0.5 if there were only a couple of visible markers, and 0.0 if there were several territorial markers.

Surveillance from property: Surveillance from property was defined in terms of how well the owners were able to overview the property from inside the building. Trees, walls and

bushes hindering the view would result in a lower score as they potentially offer a place to hide from open view. A score of 1.0 was given to a property which offered no surveillance from inside the property, 0.5 if there were some blind spots (tall vegetation etc.), and 0.0 if there was a clear view from inside the building all over the property.

Surveillance of Entry: Surveillance of entry was defined in terms of how well the main entrance could be seen from the street or neighbours. A score of 1.0 was given to a property where the main entrance was completely hidden or could only be spotted for a short moment by a passer-by, 0.5 where the main entrance was partly obscured, and a score of 0.0 where the main entrance was clearly visible at all times.

Parking: Parking was defined in terms of how and where, if present, the car was parked in relation to the property in question. Parking in an open forecourt, for example, sends a signal to a possible intruder that at any time there could be someone entering the car with full surveillance, giving the intruders little time to flee before spotted. Thus, a score of 1.0 was given, for example, to a property where the car was parked in a closed garage, parked behind the building, or where there was no sign of a car. A score of 0.5 was given to a property where there was a car and a closed garage possibly with windows, and was readily accessible from the house, and 0.0 was given to a house where the car was parked in the open, with clear view over the front of the property, or in other ways parked with a clear view of the main entrance.

Percentage of assessed properties: As noted above, due to lack of accessibility on Google Earth Street View, not all properties within a unit could be scored, and in some units no individual properties could be scored; this meant that in some units measurements are more likely to be reliable than in others. The mean percentage of properties assessed was 29.98 ($SD = 29.67$; Median = 19.00, Range 0-100). As a control, therefore, the percentage of assessed properties per unit was also included as a predictor in the regression analyses.

11.3.4. The Unit variables

Variables measured at unit level were as follows.

Urban Rural: A unit was scored one if situated in an urban area and zero if it was a unit situated in the rural area. However, when considering the Urban/Rural distinction with regard to the unit variables it became apparent that Unicef's (2012) definition of urban described in Chapter 3, i.e. "a place-based characteristic that describes the degree to which the lives of a spatial concentration of people are organized around non-agricultural activities", was too vague to differentiate reliably between small units. Instead, therefore, for this study, a more precise definition was applied. Using the relevant 2017 online statistics for the closest population cluster to the relevant unit, an urban area was defined as such if the population density was above 100 inhabitants per square kilometre and the unit had the characteristics of a town or city area, such as higher building density, public transportation hubs, dense network of roads, electrical power grids and characterized by an urban infrastructure in general. It can be noted that as building density and population density were also measured as variables in their own right (definitions to follow), there was potential for conceptual and statistical overlap. However, the zero-order associations, shown in Table 11.5, illustrate that, measured separately, these three variables had very different associations with arson rate; consequently it was decided to include all three in the regression analysis.

Territorial Markers: At the unit level, each unit was given a score of 0.0 if there were any territorial markers in the unit, and a score of 1.0 if there were no territorial markers in the unit. As above, territorial markers were defined as those items which made the unit stand out as belonging to, or have significance for, certain individuals. For example, they could be personalised signs in front of houses or communal areas, benches in front of properties or communal areas put there for use by owners, and unique or special items on properties and

communal areas, such as statues, personalised plant displays or other elements not common to all properties or areas.

Maintenance Unit: A unit was given the score of 0.0 if the unit was generally well maintained and a score of 1.0 if it was not well maintained. A unit was scored as well maintained if it gave an overall impression of being in a good state of repair and generally well looked after; for example, clean bus stops, clearly defined road surface markings, intact night lighting, etc. If an area was in disarray because of building works (trucks, cranes, cement mixer etc. present) it was scored as 1.0, on the assumption that that maintenance was undergoing.

Litter: A unit was given a score of 1.0 if there were signs of any litter in the unit and a score of 0.0 if there was no litter in the unit. Litter was defined as rubbish such as paper, cans, and bottles left lying in an open, or public, place. In this respect, litter was considered separate from maintenance. For example, if a unit had some litter in the streets but no other signs of untidiness (vandalised bus stops, worn down road surface paint, etc.), it received a score of 1.0 for litter but 0.0 for a well maintained unit.

Industry Proximity: A unit was given the score of 1.0 if the nearest industrial area was within one km of the edge of the unit, and a score of 0.0 if the nearest industrial area was one or more kilometres away. An industrial area was defined as any area allocated for industry; for example, light industry, service industry, general industry, hazardous, noxious or offensive industry, waterfront industry, and extractive industry.

High Rise Buildings: A unit was given the score of 1.0 if there were one or more high rise buildings present in the unit, and a score of 0.0 if there were no high rise buildings in the unit. A high rise building was defined as a building of at least two stories, with a separate entrance door for each story but one main entrance door, designed for more than one family.

Terrace Houses: A unit was scored as 1.0 if there were one or more terrace houses in the unit and a 0.0 if there were no terrace houses in the unit. A terrace house was defined as a house built as part of a continuous row in a uniform or partly individual style, connected wall to wall and no more than two stories high.

Public Buildings: A unit was scored as 1.0 if there were one or more public buildings in the unit and a 0.0 if there were no public buildings. Public buildings were defined as a buildings used by the public for any purpose, such as assembly, education, entertainment, or worship. Examples include, churches, municipal buildings, shelters for homeless people, train and bus stations, and libraries.

Commercial Buildings: A unit was scored as 1.0 if there were one or more commercial buildings in the unit and a 0.0 if there were no commercial buildings found. A commercial building was defined as a property from where merchandise is sold and usually marked by signs, or a shop name, etc.; for example, kiosks, gas stations, and market places.

Entertainment: A unit was scored 1.0 if there were one or more buildings associated with entertainment in the unit, and 0.0 if there were no entertainment buildings. An entertainment building was defined as one intended to provide people with amusement or enjoyment; for example, restaurants, theatres, cinemas, bars and pubs, etc.

Vacant Buildings: A unit was scored as 1.0 if there were one or more vacant buildings in the unit and a 0.0 if there were no vacant buildings in the unit. A property was defined as vacant if the building appeared abandoned and unoccupied.

Distance from Police Station: Distance to the nearest police station was measured, in kilometres, from the edge of the unit closest to the nearest police station, to this police station; this was a continuous variable.

Building Density: Building density was calculated as the number of square kilometres in the unit divided by the number of buildings in the unit. It was, therefore, also a continuous variable.

Population density: Population density for each unit was another continuous variable calculated in terms of the number of inhabitants in the local area divided by kilometres². This was achieved using the relevant 2017 online statistics for the closest population cluster to the relevant unit.

11.3.5. Coding of Units /Reliability

To help establish the reliability and validity of the scoring/coding process the researcher recruited an associate. The researcher and her associate then met regularly to compare assessments and discuss current problems in scoring the units as problems arose. A folder was prepared for each of the two coders containing a set of photos and a coding scheme for each variable. For example, in each folder there were several examples of what a fence/hedge should look like to be awarded a score of 0.0, as well as several examples of what it should look like to receive scores of 0.5 and 1.0. Having agreed on the assessment scheme, each coder then independently coded a sample (units = 3, individual properties = 15) of a third of the units on all of the variables to assess interrater reliability; the Kappa values were between .70 and .80 for all variables. According to Cohen (1960), a Kappa between 0.61 and 0.80 is considered to indicate substantial reliability.

11.3.6. Criterion Variable: Arson Rates

As noted above, the aim was then to use the features of these units to predict arson rates. The arson rates were derived from examination of the locations of arson offences for 746 cases in the main data set described in Chapter 5; i.e. the crime location of each of the 746 cases was

plotted onto to Google Earth Street View such that the number of crimes per unit of analysis could be established.

Arson rates per unit ($n = 294$) varied from 0 to 32; $M = 1.57$ ($SD = 3.56$), median = 0, mode = 0. Thus of the 294 units, the majority, 196 (68%) had no incidence of arson.

Effectively, this meant that that there was little point in classifying the criterion variable of arson rate on anything other than a binary scale; though, of course, a major advantage to this was that the data then lent themselves, once again, to analysis by binary logistic regression with arson rate as the dependent variable, and the environmental variables as predictors.

Accordingly, a unit was given the score of 1.0 if any arson cases had been reported in the unit and a score of 0.0 if no arson cases had been reported in the unit.

11.4. Results: Property Variables

On the basis of the literature reviewed in Chapter 3, in particular, the predictor variables were all coded such that high scores would be expected to relate to environmental characteristics that might make a property or unit more accessible and attractive to arsonists, and low scores to characteristics that might make them less vulnerable to arson.

Table 11.1: Descriptive Statistics for the Individual Property Variables (N = 237)

	Median	Mode	Mean (SD)	Range
Graffiti	0.00	0.00	0.01 (0.04)	0.21 (0.00 – 0.21)
Maintenance	0.25	0.00	0.26 (0.17)	1.00 (0.00 – 1.00)
Fences and Hedges	0.50	0.50	0.52 (0.20)	1.00 (0.00 – 1.00)
Marker	0.88	1.00	0.88 (0.09)	0.50 (0.50 – 1.00)
Surveillance from property	0.19	0.00	0.21 (0.16)	1.00 (0.00 – 1.00)
Surveillance of entry	0.54	0.50	0.54 (0.22)	1.00 (0.00 – 1.00)
Parking	0.45	0.50	0.45 (0.19)	1.00 (0.00 – 1.00)

As mentioned previously, due to the accessibility problem with Google Earth Street View it was only possible to derive scores for 237 (80%) of the units. The individual property

variable analyses, therefore, are based on 237 unit cases. The descriptive statistics for the individual property variables are shown in Table 11.1.

The zero-order correlations between Arson Rate and individual property variables, are shown in Table 11.2.

Table 11.2: Zero-Order Point Biserial Correlations between Arson Rate and Individual Property Variables (p values in second row)

Graffiti	Maintenance	Fences and Hedges	Markers	Surveillance from Property	Surveillance of Entry	Parking	Assessed Properties
.011	-.001	-.050	-.109	-.105	.066	-.154	-.178
.870	.989	.447	.093	.106	.309	.018*	.002**

** Correlation significant at 0.01 level (2-tailed)

* Correlation significant at 0.05 level (2-tailed)

A binary logistic regression with Arson Rate as the dependent variable and the Property Items as the predictors (see Table 11.3) predicted 73% of cases, but was not significant, $\chi^2(8) = 13.91, p = .084$, and explained only 8% of the variance (Nagelkerke $R^2 = .08$). Also, an ROC analysis showed an AUC value of .69 ($SE = .04; p < .0001$), which, although significant, would be classified as ‘poor’ by Hosmer and Lemeshow’s criteria.

Table 11.3: Binary Logistic Regression with Arson in Unit as Dependent variable and Individual Property Variables as Predictors

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(B)
Parking	-1.98	0.89	4.92	1	.03	0.14
Surveillance from Property	-1.89	1.11	2.93	1	.09	0.15
Territorial Markers	-2.53	2.04	1.54	1	.21	0.08
Surveillance of Entry	0.61	0.71	0.74	1	.39	1.84
Fences and Hedges	-0.44	0.86	0.27	1	.61	0.64
Maintenance	0.49	1.01	0.23	1	.63	1.63
Graffiti	-1.03	4.55	0.05	1	.82	0.36
Assessed Properties (control)	-0.01	0.01	2.93	1	.09	0.99

Only parking ($p = .03$) was a significant predictor of the presence of arson in the unit, and even this was in a direction opposite to that predicted; i.e. arson rates were higher when occupants parked their cars in clear view of the main entrance of the house, and/or an open space.

11.5. Results: Units

The descriptive statistics for the unit predictor variables are shown in Tables 11.4 A and B, and the zero-order associations (Phi and point biserial correlations) between Arson Rate and the various unit variables, are shown in Table 11.5.

Table 11.4 A: Descriptive Statistics for the Dichotomous Unit Variables (N = 294)

		Frequency	Percentage
Arson in Unit	No Arson	196	67
	Arson	98	33
Urban/Rural	Urban	108	37
	Rural	186	63
Markers	No Marker	215	73
	Marker	79	27
Maintenance	Not Maintained	104	35
	Maintained	190	65
Litter	No Litter	186	63
	Litter	108	37
Industrial Area Within 1km	No Industrial Area	105	36
	Industrial Area	189	64
High Rise	No High Rise	174	59
	High Rise	120	41
Terrace House	No Terrace Houses	211	72
	Terrace Houses	83	28
Public Building	No Public Building	168	57
	Public Building	126	43
Commercial	No Commercial	149	51
	Commercial	145	49
Entertainment	No Entertainment	250	85
	Entertainment	44	15
Vacant Building	No Vacant Building	275	87
	Vacant Building	37	13

Table 11.4B: Descriptive Statistics for the Continuous Unit Variables (N = 294)

	Median	Mode	Mean (SD)	Range
Police Station	25.70	8.03*	22.70 (9.21)	31.57 (0.23 – 31.80)
Population Density	51.26	13.65	757.93 (2213.67)	12071.35 (1.65 – 12970.00)
Building Density	500.00	28.00	559.95 (480.69)	5336.00 (2.00 – 5338.00)

*Multiple Modes exist. Smallest mode is shown.

Table 11.5: Zero-Order Associations (Phi and Point Biserial Correlations) between Arson in Unit and Unit Variables (p values in second row)

	Urban Rural	Markers	Maintenance	Litter	Industrial Area	High Rise	Terrace House
	.165**	.109	-.080	.015	.0001	.206**	.182**
	.005	.063	.169	.798	1.000	.0001	.002

Public Building	Commercial Building	Entertainment	Vacant Building	Police	Building Density	Population Density	Assessed Properties
.277	.154**	.169**	.145*	.362**	-.210**	-.090	-.178**
.0001**	.008	.004	.013	.0001	.0001	.119	.002

** Correlation significant at 0.01 level (2-tailed)

* Correlation significant at 0.05 level (2-tailed)

A binary logistic regression with Arson Rate as the dependent variable and the Unit items as the predictors significantly predicted 81% of cases, $\chi^2 (15) = 118.51, p < .0001$, and explained 46% of the variance (Nagelkerkel $R^2 = .46$); see Table 11.6. An ROC analysis showed an ‘excellent’ AUC value of .87 ($SE = .02; p < .0001$) according to Hosmer and Lemeshow’s criteria. Significant predictors of the presence of arson in the units were: presence of terrace houses ($p = .027$) and vacant houses ($p = .002$), longer distance to nearest police station ($p < .0001$), and building density ($p = .017$); however, in the latter case, contrary to the effect hypothesised, units with low building density were more likely to be targeted by arsonists. The presence of commercial buildings ($p = .055$) also only narrowly missed significance.

Table 11.6: Binary Logistic Regression with Arson in Unit as Dependent Variable and Unit Variables as Predictors

	<i>B</i>	<i>SE</i>	Wald	df	<i>p</i>	Exp(B)
Distance from Police	0.13	0.03	20.74	1	.0001	1.14
Vacant Buildings	1.70	0.53	9.81	1	.002	5.28
Building Density	-0.01	0.01	5.31	1	.021	1.001*
Terrace Houses	0.76	0.34	4.88	1	.027	2.14
Commercial Buildings	0.72	0.37	3.69	1	.055	2.04
Population Density	0.01	0.01	3.37	1	.066	1.001*
Assessed Properties	-0.01	0.01	3.28	1	.070	0.99
Maintenance	-0.62	0.35	3.09	1	.079	0.54
Public Buildings	0.59	0.36	2.70	1	.100	1.79
Places of Entertainment	0.75	0.46	2.60	1	.107	2.11
High Rise Buildings	0.56	0.37	2.33	1	.127	1.75
Litter	-0.44	0.38	1.33	1	.249	0.64
Industry	-0.25	0.37	0.45	1	.505	0.78
Urban/Rural	0.31	0.52	0.35	1	.554	1.36
Territorial Markers	0.05	0.39	0.02	1	.897	1.05

* The odds ratio can be interpreted as the multiplicative adjustment to the odds of the outcome, given a unit change in the independent variable. If the unit of measurement is very small compared to the size of a meaningful change, as here, even though significant, the odds ratio will be very close to one.

11.6. Discussion and Conclusion

The results of the environmental variables of this study suggest some potentially interesting, and surprising, environmental predictors of arson rates.

11.6.1. Property Variables

The regression for variables measured at the independent property level was not significant and accounted for only 8% of the variance in the arson rate scores; the AUC value was also poor. In fact, the only significant predictor was that of parking availability and this was contrary to the hypothesised direction; i.e. if inhabitants could park in close vicinity to the front of the house or in an open space in the front of the house, arson was more likely.

According to Newman (1972), the opposite should be the case as a car parked around or in

clear view of the main entrance offers the possibility of surveillance. However, interpretation of this effect is problematic given the failure of the regression overall to significantly predict arson rates; nevertheless, the fact the effect for parking was present at the zero-order level too suggests that it may have some substance. One of the limitations apparent in the present analysis was that it was not possible, with the time and resources available, to map individual offenders to offences on individual properties within units; this could be critical. For example, if the main targets in an area were vehicles, or individuals of high economic status, then one might expect offenders to target properties where cars are present and are easily identifiable and accessible, in preference to properties where parking might indicate an increased possibility of surveillance; this may have given rise to the present result.

Contrary to predictions from the literature, none of the other individual property variables (graffiti, maintenance, fences and hedges, territorial markers and surveillance from property) was significant, either in the regression or at the level of zero-order correlations. It can be noted, however, the control variable, percentage of properties assessed, was significant at the zero-order level, $r_{pb} = -.18$, $p = .002$, such that higher rates of arson were associated with a lower percentage of properties assessed and, although not significant in the regression, when this variable was removed from the regression, none of the variables was significant. Taken together, therefore, the predictive value of the variables assessed at individual property level, including the parking variable, seems somewhat questionable.

11.6.2. Unit Variables

The regression using the unit predictor variables was more successful, being significant and explaining 48% of the variance in arson rate scores, and producing an excellent AUC value. The main significant and near significant unit predictors predicted in the hypothesised directions; thus the presence of arson in a unit was significantly predicted by the presence of

vacant buildings, and a longer distance from the nearest police station, and there were near significant associations for the presence of commercial buildings and high population density. However, building density significantly predicted arson rates in the opposite direction to that hypothesised; i.e. lower building density was associated with higher arson rates. All of these effects were evident at the zero-order association level, and their effects were not influenced by the removal of the control variable (percentage of properties assessed), from the regression.

The finding regarding building density was particularly interesting as it ran counter to the prediction, from work on population density generally, that high building density might contribute directly or indirectly to crime because it may reduce social control and/or increase strain (Agnew, 1999; Bell et al., 1996; Coleman, 1990; Wirth, 1938). However, little work has been published relating to building density as opposed to population density per se, and there appears to have been nothing to date on arson. In the present study there was, in fact, no relationship between population density and building density, $\Phi = .01, p = .83$, suggesting that one cannot be assumed from the other. Moreover, as discussed in Chapter 3, the effects of population density on crime have long been contentious, some reporting no negative effects (Aiello & Thompson, 1980; Bell et al., 1996; Choldin, 1978; Wilner, 1962), and others even beneficial effects (Lindenberg, 2012; Rutkowski, Cruder, & Romer, 1983). For example, high population density might discourage offending by increasing opportunities for surveillance (Lindenberg, 2012). In the same way, therefore, low building density might encourage offending, and particularly arson offending, by lowering the possibility of detection. Notably, in the present study, population density as opposed to building density was unrelated to arson rates at the zero-order level, $\Phi = -.09, p = .12$, or when entered in the regression by itself, but it approached significance in the expected direction in the regression ($p = .066$). A selective rerun of the regression showed that the variable most responsible for

raising the predictive value of population density was distance from the nearest police station; in fact, when both were entered in the regression by themselves, high population density was a significant positive predictor ($p = .019$). This suggests that distance of the nearest police station acted to some extent as a suppressor variable for the association between population density and arson rates until taken into account; the association between the two was significant, $\Phi = .26$, $p < .0001$. However, the general finding was that population density was not a clear predictor of arson offending either by itself, or when the range full range other variables was taken into account.

Also notable was the presence of terrace houses as a significant predictor of arson offending; although not specifically identified in the literature, an association between terrace housing was predicted as compared to some other forms of housing, such as semi-detached and detached housing. Terrace housing is traditionally associated with urban environments, higher population and building densities, lower incomes, and closer proximity to public buildings and places of entertainment. The significant association with terrace housing was also evident at the zero-order level.

The finding of vacant buildings as a significant predictor of arson rates could be considered to fit with Wilson and Kelling's (1989) view that vacant properties are indicators of lack of maintenance or caring for an area, and may lead to a breakdown of control in the local community and increased criminal activity. The results showed that areas with vacant buildings were over five times more likely to be the target of arson; however, as discussed below, maintenance itself did not predict arson rates, and in any case, the relationship between vacant buildings and maintenance was not significant, $\Phi = .05$, $p = .42$. This suggests that we need some other explanation for the link between vacant buildings and arson. There could be a number of explanations for this; for example, vacant buildings may

be subject to less surveillance. Also, as the majority of arsonists do not appear to aim to endanger lives, vacant buildings mean that endangering lives is less likely.

Surprisingly, however, particularly given the overall predictive power of the regression, as with population density, none of the other unit predictors was significant, including some that one might have expected to have shown clear trends. For example, according to researchers such as Newman (1972) and Crow (2000), high rise buildings can be a high risk factor for criminal activity generally, in part because inhabitants may both sense, and have low or no control over, the area and feel no responsibility for its upkeep or defence. However, in the current study high rise buildings were not found to be a significant predictor of arson rates, though terrace houses were. Nevertheless, the presence of high rise buildings did predict arson rates highly significantly in the expected direction at the zero-order level, $\Phi = .21, p < .0001$. A selective rerun of the regression showed that high rise buildings similarly predicted arson rates when entered into the regression by itself, but it ceased to be significant when the presence of public and commercial buildings, and distance from the nearest police station, were added to the regression. If reliable and valid, this finding suggests that there may be an association between the presence of high rise buildings and arson, but it comes about less through issues of surveillance, population density and (lack of) territorial behaviours, and more because of proximity to public and commercial buildings and the possibility that high rise buildings tend to be further from the nearest police station. In fact, again, the association between the presence of high rise buildings and distance from the nearest police station was positive and highly significant, $\Phi = .22, p < .0001$. It is also worth commenting here that Newman's (1972) suggestion that areas further away from a police station are more likely to be targeted for arson, might appear obvious, but it seems that insufficient attention may have been paid to this in studies of environmental aspects of crime in general. For instance the possibility, as found here, that associations between crime, high

rise buildings and population density might be substantially influenced by the proximity of the nearest police station, is easily overlooked.

Similarly, the presence of commercial buildings and places of entertainment also positively and significantly predicted arson at the zero-order level, but did not do so in the regression. Another selective rerun of the regression showed that both were significant predictors of arson when entered by themselves, but ceased to be significant when building density, vacant buildings and distance from the nearest police station were added to the regression. Again, this suggests that the standard explanations for why commercial buildings and places of entertainment might be targets for crime, and arson in particular (such as anonymity, lack of territorial markers, and maximum impact), may not necessarily be the most predictive of crime rates. Proximity to industrial areas, however, appeared to have no predictive value in relation to arson rates at zero-order or regression level. It was Shaw and McKay's (1942) landmark study that suggested crime rates tend to be highest in and around properties closest to industrial areas. However, once again this may not be a characteristic feature of arson behaviour.

Given the predictions from Defensible Space Theory, CPTED and Incivility Theory, also surprising was the failure of the maintenance (or lack of) variable to predict arson rates, either at the individual property or unit level (see Furr & Spine, 2002; Lindenberg, 2012; Wilson and Kelling, 1982). In fact, at the unit level, though not significant at the zero-order level, it approached significance in the regression ($p = .079$) in the direction opposite to that hypothesised; i.e. low maintenance was associated with lower arson rates. A selective rerun of the regression showed that the better performance in the regression was largely due to the addition of public buildings, which appeared, at least to some extent, to act as a suppressor variable for the relationship between maintenance and arson rates. Further investigation of zero-order associations showed that public buildings were unrelated to maintenance, $\Phi = .07$,

$p = .26$, but positively and significantly associated with high arson rates, $\Phi = .28$, $p < .0001$. However, why better maintenance should show up as predictor of higher arson rates at all remains a puzzle; though one possibility is that buildings that are better maintained, whether public and commercial buildings or domestic residences, might be considered more lucrative targets, not only in terms of attracting attention, but also for purposes of fraud and robbery (followed by concealment). It is also worth noting in this context that other features potentially related to low maintenance, such as the presence of litter and graffiti, measured at the individual property level, apparently had no significant effect on crime rates.

Given the findings regarding buildings and population density, it is perhaps less surprising that the urban/rural distinction was not a significant predictor of arson rates in the regression; however, the urban/rural distinction was significantly associated with arson rates at the zero-order level. These results suggest once again that simple zero-order associations may oversimplify the relationships between crime related variables. As mentioned previously, results regarding differential crime rates in general for urban and rural areas have often been contradictory (see for example, Weisheit and Donnermeyer, 2000; Weisheit & Wells, 2001). However, interestingly, a rerun of the present regression looking at urban/rural distinction found that it was not actually building and population density that were responsible for rendering the association between urban/rural and arson rates insignificant, but numbers of vacant properties and, most important, distance of the nearest police station.

However, perhaps most surprising of all, there were no significant effects with respect to territorial markers. These were not significant in either the zero-order or regression analyses for either the individual property or unit levels. Territorial markers have been considered by some to be one of the prime environmental factors affecting crime levels (Abdullah et al., 2012; Bell et al., 1996; Bennett and Wright, 1984; Brown & Altman, 1983; Crowe, 2000; Donnelly, 2010; Newman, 1972, 1996; Perkins, Wandersman, Rich & Taylor,

1993; Weisel, 2002, 2004). However, one possibility is that the present researcher and her associate may have missed key markers, and/or some critical markers might not have been sufficiently visible. Another possibility, of course, is that territorial markers have less significance for arsonists. Relatedly, in respect to the individual property variables, neither the presence nor height of fences and hedges seemed to have an effect on arson rates. As well as affecting opportunities for surveillance, these can also sometimes act as markers (see Bell et al., 1996). It is possible that there may be characteristics of the crime of arson that make such features less important than in other crimes.

11.6.3. Conclusion

Interestingly, a number of these results are significantly in line with predictions, whilst some are significant in a direction opposite to predictions, and a number of potentially important predicted relationships failed to emerge as significant. As intimated above, this mix of results may be due to a variety of factors, not least of which might be methodological limitations, including problems with measurement sensitivity and sampling. For example, one general feature that emerges in this study is the difference in the strength of the regression models for the two levels of environmental analysis; i.e. individual property measures versus overall unit measures. Clearly, the overall unit level of measurement, and related variables, outperformed the individual property level of measurement; the AUC values being ‘excellent’ .86 and ‘poor’ .69, respectively. However, one of the issues that arose here was the difficulty in obtaining reliable estimates from the images available (i.e. from Google Earth); hence not only were data unavailable for the full range of units, but there was considerable variability in the number of properties that could be assessed within each unit.

However, notwithstanding this, it should also be noted that, to the best of the researcher’s knowledge, in many respects this is the first study of its kind. No previous study

has simultaneously investigated this range of environmental variables at unit level on crimes in general, let alone on arson rates in a European sample of arsonists. This presents the possibility that many of these effects, or absence of them, may be idiosyncratic features of crimes of arson as distinct from other criminal behaviours.

Part 3

General Discussion and Conclusions

Chapter 12

General Discussion and Conclusions

This final chapter will present a general summary and discussion of all the findings together with consideration of possible limitations, suggestions for future research, implications and some final conclusions.

12.1. Summary

12.1.1. Aims

First, to recap, the overarching theme of the current thesis was to describe and evaluate some of the main demographic and biographical factors, behavioural factors, and environmental factors associated with arson in a European sample. Then, within this overarching theme, there were four overall main aims as follows: 1) to describe and evaluate the demographic and biographical characteristics of a European sample of arsonists from rural and urban areas, such as, age, gender and nationality, ethnic background, psychiatric history, criminal record, and educational and work history; and to assess their relationships with, solo and group offending, serial and single/individual offending, and offending in rural and urban environments; 2) to describe and examine the relationships between the offence related behavioural characteristics of arsonists, within the same sample, such as travel distances, use of accelerants, use of alcohol, crime scene behaviours, and, where appropriate, previous history between victim and offender; and to assess their relationships with the demographic and biographical variables investigated under the first aim; 3) to examine the influence of a

range of architectural and structural features of the environment on arson rates, particularly those derived from Defensible Space theory, CPTED (Crime Prevention Through Environmental Design) and Incivility Theory; and from this to describe a possible framework for understanding which features and types of neighbourhoods attract fire setting behaviour and why; and 4) where possible, to assess the relative effectiveness of these variables for predicting arson rates.

It is in the context of these aims, therefore, that the following summary and discussion is presented.

12.1.2. Rationale: Summarising the Results

Given the large range of variables studied in the present thesis, it is necessary to give consideration to the best way of summarising the data and the relationships between the various elements. To this end, as has been mainly the case in the literature, first the biographical data will be summarised and discussed. Following this, Table 12.1 is presented as a schematic way summarising and integrating the regression results for the main demographic, biographical and offence related variables, classified or ordered primarily according to the offence related variables, as potentially this might be considered to make the most sense forensically. Finally, the results of the environmental variables are also summarised in schematic form in Table 12.3 and discussed.

12.1.3. Demographic and Biographical Variables

With regard to gender, overall, the present sample consisted mainly of male offenders (85% - 87%), with only a minority of female offenders (13% - 15%). This gender ratio was consistent across different subgroups very few exceptions and is generally in line with the literature from other samples and countries; it is also in line with the general trend for males

to offend at a much higher rate than females in almost every country in which studies on criminal careers have been conducted. As discussed in Chapter 6, the reasons for this have been much debated with little resolution; however, various sources of evidence seem supportive of the view that males might be more inclined to commit arson offences in their younger years because of factors such as generalised risk-taking, stimulation, frustration, machismo etc., whereas younger females in their mid and late teen years may be reacting more specifically to a dysfunctional home environment. As such, this might then account for the existence in the present sample of the second subgroup of female offenders in their late thirties and early forties, who could be *adult women reacting to dysfunction in their own homes* (marital issues, child care issues, etc.). This brings us to the results on age.

The average age of first offence in the present sample was 22 years old, whereas the modes were even younger at 13 to 14 years old at the time of first offence. As hypothesised, this fits with a general trend in the literature for arsonists to be fairly young. Notably, however, and as previously reported in the literature, females were considerably older than their male counterparts; however, the modes were similar; this was because, as noted above, the female subgroups tended to be bimodal, with a younger group of offenders (middle and late teenagers) and a second group of female offenders in their late 30s and early 40s. Interestingly, in regards to arson other studies have suggested that the age of arsonists is more in line with less serious crimes, such as delinquency. Overall, however, the present data could be construed as suggesting that both the age and motivational profiles for male and female arsonists may be different. Thus, as suggested above, the most typical male offender may be a young person out for excitement, or sensation seeking, or exhibiting machismo prowess, whereas females may be more motivated by reacting against a dysfunctional social and personal environment (hence the bimodal age distribution with the latter). To the best of the researcher's knowledge, although a general trend for females to be older has been noted in

previous studies, this exact difference in age profiles has not previously been detailed in the literature.

The main results regarding single versus serial offending are summarised and discussed in relation to the study on recidivism (see Section 12.1.5), though it is perhaps worth noting here that the majority of arsonists in the present studies were single arson offenders, which fits the general view that most arsonists are not serious career criminals.

In terms of group versus solo offending, significantly more offenders set fires in groups than alone, and there were proportionally more women among the solo offenders. Also, solo offenders tended to be older and were more likely to have a history of serial offences both including arson, and not including arson, as well as having more trouble at school, but less likely to be enrolled in school, and a greater likelihood of a psychiatric history. The literature on the biographical characteristics of solo versus group offending has been somewhat contradictory (see Chapters 2 and 4); however, these findings would suggest general support for the view that solo offenders are more likely to have a history of disruptive behaviour and mental health issues.

It was further hypothesised that, for a variety of reasons, such as opportunities, types of buildings, and population density, there would be more urban than rural offenders; and accordingly, in the full and most representative sample, 48% were rural offenders, and 52% urban offenders, which, though a relatively small difference, was statistically significant. This also fits with general trends for higher crime rates in urban areas. However, there was no support for the hypothesis that, for the reasons given above (i.e. opportunities, types of buildings, and population density etc.) urban offenders would be younger at the time of their first offence (start fires earlier) than rural offenders. In Chapter 6 it was suggested that this might have been due to possibility that these factors on urban areas might have been offset by factors such as frustration and boredom associated with an absence of social activities for the

younger population in the rural area. And, if so, this suggests that, in future research, the availability of alternative social activities and recreational distractions may be an important factor to consider when comparing rates of arson in different districts.

With regard to psychiatric history, although a number of studies suggest that mental illness is common among arsonists, only 22% in the current sample had a history of psychiatric diagnosis and /or treatment; though these figures may be biased by underreporting. Significantly more female offenders had a psychiatric history; this fits with other findings indicating that females are more represented among mentally ill firesetters. In addition, and especially notable, rural offenders were more likely to have a psychiatric history than urban offenders; which goes against the prevailing view that pressures of living in cities, increases the risk of mental health problems. However, as suggested in Chapter 7, perhaps the most likely reason for this is that arsonists living in urban areas are also more likely to be living with parents and enrolled in school, both of which factors that tend to be associated with lower rates of mental health issues.

In line with previous research, the majority of the offenders were White, and citizens of the country assessed (here Denmark). Consequently, as noted in Chapter 7, and contrary to some media speculation and public opinion, there was clearly no evidence that non-Whites or those of non-Danish nationality were overrepresented in the sample (Müller & Özcan, 2007).

Notwithstanding the general approach adopted in this thesis (i.e. not to attempt to collapse and over simplify the data), in Chapter 7 it was argued that if one wanted to take an overall perspective on the present findings, the picture that seems to be emerging seems to one of three possible divergent trends in the data corresponding to different categories of offender. These were identified as follows: 1) the more frequent opportunistic arsonist, predominantly male, mainly young, at school or unemployed, often living with parents, and often offending in groups; 2) a less frequent, but more serious, often more persistent serial

offender, who is more likely to be older at the time of their first offence, employed, have a history of disruptive behaviour and mental health issues, and operate alone; and 3) a category of mainly female offenders who are not more likely to be serial offenders, but who are also older at the time of their first offence than those in first category, have mental health issues, operate alone, and are more likely than those in the other categories to have been living in an institution, and/or divorced.

12.1.4. Offence Related Variables

Consideration of offence related variables in the present thesis started with the relationships between arson targets. As reported in Chapter 8, the main target chosen was residential property (30%), followed by targeting miscellaneous items (23%), and the remainder were broadly equivalent ranging from 15-18%; though businesses were a little lower (10%).

With regard to those who had used more than one target, four main patterns appeared to emerge; i.e. 1) those who targeted residential properties were significantly more likely to target themselves and their own homes, and less likely to choose other targets; 2) those who targeted schools were significantly more likely to target public buildings, and vehicles, but less likely to target their own homes; 3) those who targeted businesses were less likely to target vehicles, but otherwise targeting of businesses was relatively discrete and showed non-significant negative trends as regards other targets; and 4) those who targeted miscellaneous objects tended to be less likely to target residential buildings, public buildings and vehicles.

Again, to the best of the researcher's knowledge, there are no equivalent data in the literature to enable comparisons or provide possible explanations for these figures and relationships. However, as noted in Chapter 8, some insights into this pattern of findings may be gained from the regressions examining the relationships between other variables and the selection of targets. With these considerations in mind, we can utilise Table 12.1, which, as

mentioned previously, summarises the regression results classified primarily with the most forensically relevant offence related variables as the dependent variables and the other offence related variables, and demographic and biographical variables as predictors.

Table 12.1: Summary Table Predicting Offence Related Variables from other Offence Related Characteristics and Demographic and Biographical Variables (OR denotes Odds Ratios; sign denotes direction).

Offence Related Behaviours		OR	Demographic/Biographical	OR
Target Residential	Victim Ex-Partner	8.43	Gender (Male +)	-3.03
	Lives Endangered	6.16	Age	1.04
	Group/solo	-2.27	Alcoholism History	2.50
	Multiple Sites	3.23		
	Alert After Fire	3.00		
Target Business	None Specific	-	Convictions. Exclud. Arson	4.75
			Psychiatric History	-5.56
Target School	Lives Endangered	-3.13	Living w/parents	22.39
	Multi Items Fired	4.01	Unemployed	-4.17
	Planned	-3.13		
	Material Brought	2.74		
	Remained/Returned	-6.67		
	Alcohol Use	-2.56		
Target Public Building	Multiple Items Fired	5.15	Convictions. Exclud. Arson	-4.76
	Group/solo	2.94	Urban/Rural	2.33
	Alert After Fire	-12.50	Gender (Male +)	5.09
	Alcohol Use	-5.56	Psychiatric History	5.78
Target Vehicle	Victim Known	-33.33	Age	-1.10
	Prior Viol to Victim	10.75	School Pupil	-6.67
	Lives Endangered	-16.67	Psychiatric History	-4.17
	Accelerant Used	5.21	Alcoholism History	-3.85
	Material Brought	2.92		
	Alert After Fire	-14.29		
	Alcohol Use	9.74		
Target Miscellaneous	Lives Endangered	-3.70	Convictions All	3.05
	Multiple Items Fired	3.85		
	Multiple Sites Fired	-5.88		
	Accelerant Used	-2.70		
	Alert After Fire	2.47		
Target Self	Prior Viol to Victim	3.76	Gender (Male +)	-5.26
	Multiple Sites Fired	4.68	Under/Over 18	22.35
	Accelerant Used	-6.25	Living in Institution	9.80
Target Own Home	Lives Endangered	8.46	Gender (Male +)	-3.45
	Group/Solo	-3.45	Living in Institution	7.34
	Alert after Fire	2.09		

Table 12.1 Contd.:

	Offence Behaviours	OR	Demographic/Biographical	OR
Offence Planned	Target School	-4.17	Ethnicity	4.94
	Target Vehicle	-2.56	Urban/Rural	-2.27
	Target Misc.	-2.70	Age	-1.05
	Victim Known	3.52	Living in Institution	-3.85
	Prior Viol to Victim	2.68	Living w/Parents	-4.00
	Lives Endangered	2.22		
	Material Brought	8.66		
Group/Solo Offending	Target Residential	-3.13	Previous Arson	3.30
	Prior Viol to Victim	-5.56	Convictions	-4.00
	Prior Threat to Victim	12.42	Criminal Damage	-1.90
	Accelerant Used	2.38	Urban/Rural	-1.08
	Material Brought	2.00	Age	4.21
			School Pupil	-3.33
			Psychiatric History	-3.70
Multiple Fire Sites	Target Residential	8.26	School Trouble	
	Target Business	4.53	Gender (Male +)	-2.17
	Target School	5.24	Unemployed	-2.63
	Prior Viol to Victim	-3.57	School Trouble	2.47
	Lives Endangered	3.85		
	Multiple Items Fired	12.64		
Multiple Items Fired	Target School	4.11	Unemployed	-2.38
	Target Public Building	17.94		
	Target Miscellaneous	15.71		
	Target Own Home	7.82		
	Fire Multiple Sites	15.72		
Accelerants Used	Target Business	3.02	Previous Arson	2.60
	Target Vehicle	7.82	Convictions. Exclud. Arson	4.02
	Target Self	11.11	Criminal Damage	-3.13
	Victim Known	8.62	Institution	-4.00
	Group/Solo	2.50	School Pupil	-3.13
	Multiple Sites	2.37	School Trouble	-3.13
Materials Brought	Target School	2.70	Criminal Damage	-3.03
	Target Public Building	2.93	Gender	2.53
	Target Vehicle	4.06	Age	-1.04
	Target Misc.	2.46	Manual Work	-3.45
	Target Self	12.50		
	Victim Known	2.38		
	Planned	8.50		
	Group/Solo	2.64		
Alcohol Use	2.56			
Alert Given	Target Residential	4.06	Convictions. Exclud. Arson	4.38
	Target Miscellaneous	2.44	Criminal Damage	-7.69
	Multiple Items Fired	2.78	Urban/Rural	2.44
	Remained/Returned	2.26	Alcoholism History	4.44
Remained/Returned	Target School	-5.00	Convictions All	-2.86
	Own Home	3.88	Over/Under 18	4.93
	Lives Endangered	3.69	Psychiatric History	2.78
	Alert After Fire	2.25		
Alcohol Use (during crime)	Target School	-3.57	Criminal Damage	6.94
	Target Public Building	-7.14	Urban/Rural	-3.73
	Target Vehicle	4.33	Over/Under18	3.43
	Victim Known	4.00	Living in Institution	-2.94
	Victim Ex-Partner	4.03	Psychiatric History	-4.76
	Group/Solo	-1.96	Alcoholism History	13.13
	Material Brought	-3.33		
Travel Distance 0.00 - >0.00 km	Lives Endangered	-1.18	Psychiatric History	-5.00
	Target Own Home	-7.14	Alcoholism History	3.19
Travel Distance ≤ 5/ >5 km	Target School	-2.63	Urban/Rural	-3.33
	Target Vehicle	3.75	Over/Under 18	3.06
	Victim Known	2.98	School Pupil	-2.50
	Planned	2.09		

In many respects, one could argue that, as a resource, Table 12.1 could reasonably be left to speak for itself, without imposing further subjective comment, such as inferring patterns and motives; however, given the general tendency in the literature to look for and interpret data patterns, it seems appropriate to make some attempt to do this so that possible links and comparisons, both within the data and with the wider literature, can be made. It can further be noted here that, rather than simply repeating what has already been said, the following is intended to add to the preceding summaries and discussions by summarily combining the results from the demographic and offence related regressions.

With regard to targets, not surprisingly, there was some degree of overlap between the predictors of targeting of residential properties and targeting one's own home, in particular endangering lives, operating alone and being female. It could be argued that these observations fit with those on the literature suggesting that females tend to choose targets motivated by personal motives such as revenge and dysfunctional family patterns (Harmon et al., 1985; Bourget & Bradford, 1989; Burton et al., 2012). Relatedly, targeting a residential area was also more likely if the offender had a history of alcoholism, which fits with literature suggesting revenge arsonists tend to have alcohol issues (Inciardi, 1970; Wood, 1999). However, targeting one's own home was also associated with, giving an alert. As noted in the Chapters 7 and 8, setting fire to one's own property could possibly suggest insurance fraud; and in this context, giving an alert might serve to limit the damage and make a claim more credible. It is very likely, therefore, that multiple motives may be involved. Not surprisingly, targeting oneself was associated with previously having done harm to oneself, but also this was the only category of offences where female offenders outnumbered males. One possibility, suggested in Chapter 9, is that, although both male and female firesetters often come from dysfunctional homes (Sapp, Icové et al., 1994), female firesetters react to the dysfunction in a different way and tend more to turn to physical self-harm. Targeting

oneself through arson may thus reflect a specific way of responding to a breakdown of established social bonds, especially amongst those who are older, and more vulnerable due to experiences of living in an institution (Shine et al., 2009).

In contrast, there were no significant offence related predictors of targeting businesses. There were, however, two significant demographic predictors of targeting a business; i.e. more likely to have convictions other than arson, and less likely to have a psychiatric history, suggesting again those who target business properties might do so, more or less exclusively, for insurance fraud or other monetary gain, rather than personal motives. The offence related variables associated with targeting schools included spontaneously bringing materials, but not endangering lives, planning, remaining or returning, or using alcohol. Significantly also, offenders who were living at home and unemployed were more likely to target schools. This suggests that the motives for targeting schools were likely to be neither personal, nor for financial gain, but more for stimulation and excitement; i.e. thrill seeking. There appeared to be no overall pattern of predictors for targeting public buildings, hence while some might give the impression that targeting of building buildings is related to excitement or thrill seeking, others, like suggest more personal motives may be involved. It could, of course, be the case that 'public buildings' is too general a categorisation, and that different predictors apply to different public buildings. This is another obvious area for future research.

Targeting vehicles was also associated with a range of offence related behaviours all of which these could be construed as possible indicators of 'non-personal' criminal motives such as aggravated theft, and attempting to destroy evidence (say of a getaway car). In addition, being both younger at the time of the first offence, as well as less likely to be enrolled at school, suggests that, although offenders who target vehicles tend to be younger, they are again perhaps in it for more than excitement and stimulation; i.e. the motives are

more likely to be related to monetary gain or crime concealment. Targeting of miscellaneous objects was associated with a range of offence related characteristics indicating perhaps that offenders are not attempting to make a statement or attempting to gain financially but were offending simply out of boredom, or for some excitement. The fact that in the correlational analysis, those who targeted miscellaneous objects tended to be less likely to target residential buildings again suggests that the motives may well have been more opportunist and more a result of factors such as boredom (rather than revenge or more serious criminal intent). To the best of this researcher's knowledge, this aspect of arson has not previously been explored in the literature.

With regard to other offence related variables, planning of firesetting was significantly associated with a range of variables including less likely to target a school, vehicle or a miscellaneous object, having been violent to the victim prior to the firesetting, endangering lives, bringing material to the crime scene, and knowing their victims. Arguably these fit with the idea suggested in Chapter 8 that planning of offences may be a particular feature for those with personal motives such as revenge or some sort of personal vendetta; i.e. planning could be a prime indicator of those who deliberately seek to harm someone in particular. Also further analysis showed that it is offenders who are younger at the time of their first offence, but not living with their parents, who are most likely to plan their offences. In Chapter 9 this was interpreted as possibly indicating that younger offenders coded as neither living with parents nor institutionalised, and thus perhaps receiving little guidance or potential sanctions from authority figures, were most likely to plan their offences.

With regard to group versus solo offending, the overall pattern of predictors could be considered to support previous research indicating that solo offenders are more likely to be psychologically disturbed and have a psychiatric history than group offenders (Wood, 2000; Hickie & Roe-Sepowitz, 2010); i.e. factors which might predispose them to target specific

individuals in residential areas. As noted in Chapter 9, some of these findings were unexpected. For example, given this profile, one might have expected female gender also to show up as a significant predictor of solo offending; and, indeed, being female significantly predicted solo offending when entered in the regression by itself. However, it ceased to be significant when enrolled at school was added; i.e. enrolment at school (or lack of it) better accounted for the association between gender and solo/group offending than gender per se.

Not surprisingly, firing multiple fire sites predicted firing multiple items, and the pattern of significant predictors could possibly be considered a sign of a very goal oriented offender, determined to start the fire possibly for monetary gain or revenge, but perhaps not usually prone to violence. As well as firing multiple sites, setting fire to multiple items was similarly predicted by a fairly heterogeneous set of factors may influence firing multiple items; though in Chapter 9 it was suggested that firing multiple items might capture something about the modus operandi of the more serious offender who is more likely to be employed, and intent on having maximum impact on his or her target, rather than someone enrolled at school or unemployed who is experimenting or thrill seeking.

The use of accelerants was associated with a fairly wide range of offence related and demographic and biographical variables including group offending. As suggested in Chapter 8, arguably the range of targets associated with the use of accelerants, and the association with group offending, could be construed as indicators of a positive relationship between the use of accelerants and more general organised criminal activity. And, accordingly, in Chapter 9 it was argued that the demographic variables i.e. previous convictions, not being institutionalised, not enrolled in school or having trouble at school, and less likely to be engaged in vandalism/criminal damage etc., could also be considered possible indicators of offenders more likely to be engaged in organised criminal activity, rather than out for excitement or opportunistically wanting to target specific individuals for personal reasons.

Materials brought to the scene were associated with most of the targets investigated (the exceptions were self and own home), as well as another heterogeneous range of offence related behaviours. As noted in Chapters 8 and 9, it is difficult to discern any particular patterns in this set of results, though it was suggested that, despite the degree of improvisation implied, they might fit best as an indication of more planned and organised young offender group based criminal activity as distinct from opportunistic offending (including vandalism) or arson committed for more personal reasons.

As noted in Chapters 8 and 9, once again, there are no obvious explanations in the literature for the findings regarding giving an alert; alcoholism, for example, tends to be associated with firesetting behaviour in general (Eidsson, 2005; Geller, 2008; Sapp, Hobort et al., 1994). However, it was suggested that the association with residential and miscellaneous targets, multiple items fired, and remained returned, could variously be interpreted in terms of offenders trying to absolve themselves of responsibility (in the case of insurance fraud involving personal property, for example), limit damage effects, and/or offending for excitement or stimulation (see Lewis and Yarnell, 1951; Inciadi, 1970). In the same way, the demographic variables here could reflect those most likely to be involved in these kinds of behaviours (as distinct from say, organised criminal activity, or less purposeful vandalism/criminal damage).

Again, as noted in Chapters 8 and 9, nothing in particular was found in the literature regarding remaining at the crime scene and the predictor variables reported here. However, it was argued that this pattern would appear to support the view that giving an alert and staying or returning to the fire are characteristics not limited to ‘excitement arsonists’ wanting to watch the outcomes of their behaviours (Lewis & Yarnell, 1951; Inciadi, 1970), but may also contain characteristics of offenders who target residential properties for personal reasons, such as revenge, and/or fraud, or for other reasons related to psychological dysfunction.

Alcohol use before and/or during the crime was associated with another wide range of variables. In Chapter 8 it was commented that although a number of studies have indicated the very wide use of alcohol during arson offending, only 31% of the offenders in the present sample were under the influence of alcohol at the time of the crime, and this is actually lower than recent estimates of the use of alcohol in violent crimes in the UK (Office for National Statistics (2015)). Nevertheless, the fact that the offender was more likely to be under the influence of alcohol when he or she knew the victim suggests that this may be an identifying feature of arson behaviour; and correspondingly, the predictors of operating alone, knowing the victim, and targeting partner, appear to fit with Felson and Staff's (2010) finding that alcohol use was greater with dispute-related violence.

In the present sample, the mean travel distance was 13.6 km, which as discussed in Chapter 8, is considerably greater than mean travel distances previously reported not only for arson but many other kinds of crime (Fritzon, 2001; Harling, 1972). The reasons for these discrepancies with other results are not obvious, though the results for the present sample appear to have been particularly influenced by a number of offenders who travelled very long distances. Whether this is a particular feature of arson in Denmark or something idiosyncratic to the particular sample used, remains to be established. The regression analyses showed few significant predictors of travel distance in terms of the offence related and demographic characteristics; however, as detailed in Chapter 9, the picture that emerges here, is that the person most likely *not* to travel at all is the older, mentally ill, firesetter who might set fire to his or her own home.

A further breakdown of the data in Chapter 8 showed a curvilinear effect for age at first offence and travel distance, indicating that those who did not travel at all were oldest, followed by those who travelled over 5 km, whereas those who travelled an intermediate distance tended to be younger than both of the other groups; again, if age at first offence and

age at the time of committing most crimes are related, this might make sense as those travelling longer distances would tend to have cars, and be prepared to travel longer distances to target specific areas and/or people. As noted in Chapter 8, one can also see a possible overlap here with Fritzon's (2001) proposal that very short travelling distances (< 1 km) are more associated with and acts of despair, and attention seeking behaviour, whereas longer distances are associated more with thrill seeking, revenge, or generally as a planned attack against a specific person.

As a general observation on these findings for offence related behaviours, it is notable that all of the regression models and their associated AUC values were significant, indicating that, as a general principle, it may be possible to predict particular offence related behaviours and characteristics from demographic and biographical characteristics in a statistically reliable way. However, arguably what is more striking are the differences between the various offences not only in terms of their relationships with other offences, but with demographic predictors. This very obvious diversity would appear to provide a vindication of the overall approach adopted in this thesis; i.e. the idea that attempting to collapse or force these kinds of data statistically into large groupings and/or components may inevitably lose the fine detail that may have most forensic relevance.

12.1.5. Recidivism: Serial Offending Reconsidered

In Study 5, Chapter 10, the aim was to attempt to estimate which variables from Studies 1- 4 would be most likely to affect individual arson offending rates and, thereby, identify those individuals most likely to offend again. As recidivism was not per se measured in this thesis the proxy measure of previous convictions for arson was used, as this has been demonstrated to be the most reliable predictor of actual recidivism in a variety of studies. In this respect,

therefore, this section can also be used to summarise the main results for single versus serial offending.

Table 12.2: Summary Table of Significant Predictors of Serial Offending from Demographic and Biographical, and Offence related behaviours with Odds Ratios (OR); sign denotes direction.

	Demographic and Biographical	OR	Offence Related	OR
Serial Offending	Convictions Excl Arson	4.39	Target Vehicle	2.88
	Urban/Rural	2.70		
	Gender	3.91		
	Enrolled at School	-2.94		
	Manual Work	- 3.22		

The relevant significant regression results are summarised in Table 12.2. Overall, the results showed that demographic and biographical factors tended to be the best predictors of previous convictions for arson. As noted in Chapter 10, the finding that previous convictions excluding arson was one of the strongest predictors of previous arson convictions, fits well with the available literature on serial arson and arson recidivism. However, gender only became significant, when ‘enrolled at school’ was added to the regression, suggesting that school enrolment may act as a suppressor variable on the relationship between gender and serial offending; i.e. it is young male offenders who are not at school who are at greatest risk for serial offending. Similarly, being an urban offender was not significant as a predictor of previous convictions for arson when entered into the regression by itself, but became significant when ‘enrolled at school’ was entered in this study; like male offenders, urban offenders who are not enrolled at school may be particularly at risk for serial offending.

As noted earlier, in accordance with previous findings, and as hypothesised, there was a significant trend at the zero-order level for serial offenders to be older at time of first offence. However, this did not emerge as significant in the regression, though there was a

trend in the same direction. Further analyses found that a significant effect for age was also contingent upon whether enrolled at school was included (i.e. it ceased to be significant when enrolled at school was included), which may be important given the inconsistencies in the literature (Edwards and Grace, 2014; Kennedy, 2006; Kolko and Kazdin, 1992; Slavkin, 2001; Stewart & Culver, 1982); i.e. the results suggest that not attending school may carry a considerably greater risk for serial convictions for arson than age of first offence per se.

In the same way, although not living with parents, being employed and having a psychiatric history were all significant predictors of previous convictions for arson, when entered by themselves, each ceased to be significant when 'enrolled at school' was entered into the regression. Consequently, in Chapter 10 it was concluded that 'not being enrolled with school when committing an arson offence' may perhaps be one of the best ways of capturing a range of variables that may related to serial offending; indeed, this denotes a theme running through a number of other results in the thesis; i.e. 'not at school' appears to be a particular risk factor for variables relating to serious arson offending. As also mentioned in Chapter 10, it is all the more noticeable, therefore, that 'enrolled at school' is rarely, if at all, considered at all considered as a variable in studies of serial arson and recidivism, even with children and adolescents and this could possibly account for some of the inconsistencies in the literature related to gender and age, in particular. Correspondingly, the reasons why 'not enrolled at school' would be so prominent have yet to be investigated in the literature.

Nevertheless, there are potentially numerous reasons why not being enrolled in school might influence arson offending. For example, if the young male is not attending school he might in some ways already show a pattern of disassociation with the rest of the society, who expect him to take an education. Although young single offenders enrolled at school may engage in arson because of boredom or for stimulation, it could be that serial arsonists more extreme thrill seekers; hence school may not be sufficiently stimulating and they may seek

out other ways of entertaining himself by engaging in risky illegal activities including firesetting. Alternatively or additionally, serial firesetters may be motivated more by some of the other factors often associated with arson, such as repeated attempts to achieve a sense of power in situations where they feel they have none, or a desire to exact revenge. For younger offenders, in particular, any such tendencies might then be exacerbated by the lack of good authority associated with not being at school and living away from parents. In fact, if a youngster is excluded from school for whatever reason (troublesome behaviour etc.) this could act as a prime for behaviours frowned upon by society, as well as providing the individuals concerned with a lot of spare time on their hands.

However, as noted also in Chapter 10, the appearance of 'manual work' with a negative beta value (i.e. not a manual worker) as a predictor of serial offending was more perplexing, but further analysis indicated that the appearance of this as a significant predictor was contingent upon the inclusion in the regression 'not enrolled at school' again, but also 'employed'; i.e. in combination with these other variables, 'not involved in manual work' may be picking up a category of offenders who may be particularly predisposed to serial offending, and are characterised by not being enrolled school, and being employed, but not as a manual workers. Although there were insufficient data to accurately identify the employment status of the majority of those offenders who were employed, this result suggests a potentially fruitful useful avenue for future research; i.e. employment may be a way of differentiating between arson committed out of boredom or frustration, and arson committed for personal reasons or financial gain.

Of the offence related characteristics, the only significant predictor of serial arson offending was targeting a vehicle. As noted in Chapter 10, the reasons for this are not immediately obvious; in Studies 3 and 4, targeting a vehicle was associated with the use of accelerants, and not being enrolled at school, which one might associate with offenders who

are likely to engage in serious repeat offending, rather than a ‘one off’, spontaneous or opportunist attacks. Also, Edwards and Grace (2014) identified criminal damage, which would include vehicle arson, as one of their main predictors of arson recidivism. However, even this failed to remain significant when entered into a model together with the demographic and biographical factors.

The main conclusion drawn from Study 5 was that, when attempting to identify the main risk factors for serial arson and potential arson recidivism, it is important to take into consideration the influence of some very obvious demographic variables, these include employment status, and urban/rural location, but potentially most important, whether the offender committed arson while not enrolled at school. Indeed, these variables may outperform more obvious and more researched predictors as potential risk factors. Significantly also, they suggest that demographic and biographical variables may be more useful in predicting serial arson and potential arson recidivism than offence related or crime scene variables.

12.1.6. Environmental Variables

The aim of final study in the thesis, Study 6, was to assess the relative influence of a variety of additional environmental variables on arson rates (in this case the presence or absence of arson in a property or unit). Table 12.3 summarises the significant predictors.

Table 12.3: Summary Table of Significant Predictors of Presence of Arson from Property Variables and Geographical Unit Variables with Odds Ratios (OR); sign denotes direction.

Individual Property		OR	Unit	OR
Presence of Arson	Parking	-7.14	Terrace Houses	2.14
			Vacant Buildings	5.28
			Dist from Police Stat	1.14
			Building Density	-1.001

Somewhat surprisingly, the overall regression for the individual property variables as predictors of arson was not significant. The only significant predictor in the unsuccessful model was parking, and even this was significant in the opposite direction to that predicted; i.e. it was found that if inhabitants could park in close vicinity to the front of the house or in an open space in the front of the house, arson was *more* likely. By way of explanation, in Chapter 11 it was suggested that because, with the time and resources available, it was not possible to map individual offenders to offences on individual properties within units. If the main targets in an area were vehicles, or individuals of high economic status, then one might expect offenders to target properties where cars are present and are easily identifiable and accessible.

The absence of any effect for territorial markers is particularly notable given the considerable emphasis that has been placed on this in the literature as an influence on offending in general. One possibility is that the criteria for such markers (and other the property variables), and the methods used in Study 6 (Google Earth) were insufficiently sensitive to measure accurately the variables. Alternatively, given the absence of research on the relationship between these variables, it could be that all or most of them simply do not reliably apply to arson. Then again, it might be some feature of the Danish sample; perhaps Danes have a distinctive relationship with environmental variables. Take Graffiti, for example, which was not a significant predictor in the current study; both Defensible Space theory and CPTED emerged in the 1970s, whereas in the late 1990s graffiti as a form of street art became more acceptable emerged especially in metropolitan areas (Young, 2014). Indeed, sometimes street art is used (legally) in day care institutions in Denmark.

Also, sometimes the exact predictions that one might make for environmental variables are not straightforward. Hence, fences and hedges can act as instigators to crime, because offenders can hide behind them (Newman, 1972; Bell et al., 1996); on the other

hand, they could act as territorial markers and reduce the likelihood of crime. Another case in point concerns surveillance; i.e. variables that affect whether offenders can be seen. Several studies have found a relationship between low dense vegetation and high crime rates (Fisher & Nasar, 1992; Nasar, Fisher & Grannis, 1993; Stoks, 1983), as it provides a potential hiding place for criminals. However, other studies have found a negative correlation between vegetation and crime (Kuo, 2003; Kuo & Sullivan, 2001), as beautification using vegetation in well-designed green areas is likely to attract bystanders (Troy, Grove & O'Neil-Dunne, 2012). Whatever the reasons, however, there must be a question mark over the utility of individual property variables in predicting arson.

The regression using the unit variables to predict arson was considerably more successful (for a summary of results see Table 11.6). Most of the main significant and near significant unit predictors predicted in the hypothesised directions; thus the arson in a unit was significantly predicted by the presence of vacant buildings, and a longer distance from the nearest police station, and there were near significant associations for the presence of commercial buildings and high population density. In contrast, certain variables were not significant despite fairly strong expectations that they might be, for example, territorial markers, litter, and high rise buildings; or were significant or approached significance but in the opposite direction to that predicted, as in the cases of building density, terraced housing and maintenance.

As mentioned previously, it is often difficult to make directional predictions about environmental variables because a number of competing factors may be present that may influence how a variable operates in a particular context. For example, as noted in Chapters 3 and 11, given the predictions based on work on population density generally, one might expect high building density to contribute directly or indirectly to crime because it may reduce social control and/or increase strain (Agnew, 1999; Bell et al., 1996; Coleman, 1990;

Wirth, 1938). However, although in Study 6 there was indeed a trend for high population density to predict offending (though this seemed to be highly influenced by distance from the nearest police station), population density and building density were unrelated, and high building density was related to lower rates of arson. As suggested in Chapter 11, it could be the case, therefore, that high population density increases the risk of offending because of the various social factors previously identified, whilst low building density might encourage offending by lowering the possibility of detection.

The presence of terrace houses as a significant predictor of lower rates of arson was particularly interesting, as again there seems to be nothing specific in the literature with regard to this variable. Compared to some other forms of housing, as terrace housing has traditionally associated with urban environments, higher population and building densities, lower incomes, and closer proximity to public buildings and places of entertainment; consequently, one might expect association between terrace housing and increased rates of arson. However, one possibility is that, notwithstanding the other considerations, terraced housing may have high defensible space characteristics; i.e. inhabitants may feel they have more control over their environment, feel more responsibility for it and their co-inhabitants, and, in particular, feel safe (Crowe, 2000; Newman, 1972; Schneider & Kitchen, 2002).

As expected, higher rates of arson were associated with vacant buildings. According to Wilson and Kelling (1982), vacant buildings are indicative of an overall lack of maintenance and caring, which according to the predictions of Defensible Space Theory, CPTED and Incivility Theory, should make them vulnerable to arson attacks (see also Furr & Spine, 2002; Lindenberg, 2012).

Amongst the other variables that somewhat surprisingly showed no predictive trends was high rise buildings. According to researchers such as Newman (1972) and Crow (2000), high rise buildings are a high risk factor for criminal activity generally because residents

sense and have low or no control over the area and feel no responsibility for its upkeep or defence. However, as noted in Chapter 11, a rerun of the regression showed that high rise buildings predicted arson rates when entered into the regression by itself, but it ceased to be significant when the presence of public and commercial buildings, and distance from the nearest police station, were added to the regression. Consequently, it was suggested that although there may be an association between the presence of high rise buildings and arson, but it comes about less through issues of surveillance, population density and (lack of) territorial behaviours, and more because of proximity to public and commercial buildings and the possibility that high rise buildings tend to be further from the nearest police station.

At this point in Chapter 11 it was also mentioned that although Newman's (1972) suggestion that areas further away from a police station are more likely to be targeted for arson, might appear obvious, it appears that insufficient attention may have been paid to this in studies of environmental aspects of crime in general. Thus, for example, the possibility that associations between crime, high rise buildings and population density might be substantially influenced by the proximity of the nearest police station, is easily overlooked.

Given the findings regarding buildings and population density, it is perhaps less surprising that the urban/rural distinction was not a significant predictor of arson rates in the regression; though it was significantly associated with arson rates at the zero-order level. The assumption was that arson would be higher in urban areas for a because of its relationship with a variety of factors such as population and building density, high rise buildings, opportunities, disillusionment with urban living etc. However, a rerun of the regression looking at urban/rural distinction found that it was not actually building and population density that were responsible for rendering the association between urban/rural and arson rates insignificant, but numbers of vacant properties and most important, yet again, distance of the nearest police station.

Finally, in line with findings at the individual property level, unit territorial markers failed completely to predict arson rates. Presumably the same reasons for the failure of the variable to predict arson at the individual property level could apply here; i.e. lack of sensitivity of measures/methods, the possibility that this variable does not apply to arson as it does to other crimes, and/or it is a feature of the present sample.

As noted in Chapter 11, the very mixed results for the environmental variables could have been due to a variety of factors; hence the relative failure of the individual property variables to predict arson offending could have been influenced by the difficulties in obtaining accurate data at this level. However, given that, to the best of the researcher's knowledge, no previous study has simultaneously investigated this range of environmental variables at unit level on crimes in general, and certainly not in a European sample of arsonists, the results could also reflect idiosyncratic features of crimes of arson.

Another related feature that stands out, however, is the mismatch between the zero-order correlations and the final regression results in some cases, which suggest that the reasons why certain variables might successfully predict offending may not necessarily be those most popularly espoused in the literature. Perhaps the most striking example was the case of high rise buildings predicted arson rates when entered into the regression by itself, but ceased to be significant when the presence of public and commercial buildings, and distance from the nearest police station, were added to the regression. This invites the possibility that an association between the presence of high rise buildings and arson may come about less through the standard explanations of surveillance, population density and (lack of) territorial behaviours, and more, or at least as much through, proximity to public and commercial buildings and the possibility that high rise buildings tend to be further from the nearest police station. The same occurred for commercial buildings and places of entertainment which were significant predictors of higher arson rates arson only when entered by themselves, but ceased

to be significant when other variables, including again distance from the nearest police station were added to the regression. Importantly, these possibilities would not have come to light had not these variables been measured and analysed collectively.

12.2. Limitations and Future Research

Before assessing possible implications of the present findings overall, it is important to make some observations and comments about the practical and methodological limitations of the studies reported in this thesis and aspects that could usefully be followed up and explored in future research.

12.2.1. Practical and Methodological Limitations

Some of the limitations have already been mentioned in Chapter 5, and also, in the next section, a number suggestions for future research will be provided, a number of which, by definition and implication, involve elements that were missing from the present studies.

As noted earlier, there were some familiar problems and limitations with regard to the archival data used in many of the studies. These data were not collected originally for research purposes and were gathered from a number of different sources; factors which obviously may affect their reliability and generality. For example, it is common in archival data for cases to be underreported (Canter & Cohen, 1980; Riedel, 1990; Rokaw, Mercy, & Smith, 1990; Tennenbaum, 1993); however, cases may also sometimes be overreported according to how local police stations and or districts handle the data. In addition, because of limited access to the archival data, it was not possible to conduct an interrater reliability coding of the biographical and offence related behaviours. Fortunately, however, in most instances, the coding was fairly self-evident and straightforward (age, gender, urban or rural offending, solo or single-offending etc.) such that subjectivity in coding was minimised. With

regard to the environmental variables considered in Chapter 11, it was possible to assess interrater reliability, which was satisfactory; however, a number of other practical limitations occurred with these data, including problems with measurement sensitivity and sampling. One particular issue was the difficulty in obtaining reliable estimates from the images available (i.e. from Google Earth); hence not only were data not available for the full range of units, but there was considerable variability in the number of properties that could be assessed within each unit. Another issue concerned the availability of the Google Earth Street View photos, which sometimes varied in terms of the dates when they were taken, and did not necessarily coincide with the arson data; for example, some photos were taken in 2013 and 2015, whereas the arson records were collected for the period 2002 to 2010. Although, as mentioned earlier, it seems unlikely that this would have systematically affected the results, this is something to be considered in future research (for example, where discrepancies in dates occur, more attention could be paid to records of changes in development and land use).

However, perhaps most important, as in most empirical studies of this kind, issues arise as to the overall limitations of the sample, not only in terms of sample size but how the sample was constituted. As well as limitations arising from sampling in only two districts, all of the cases employed in the present thesis involved perpetrators who had been caught, whereas one could argue that the really clever perpetrators are not likely to be caught and as such do not feature in the sample. These again might lead to underreporting of cases. Relatedly, as noted in Chapter 11, the coding of Urban/Rural was applied using different definitions in the two data pulls (Police and Google Earth). In the first, the division involved a broad separation in terms of two districts broadly differentiated in terms of the Unicef distinction between agricultural and non-agricultural spacial concentration. It became evident, however, that this was too broad to make meaningful distinctions between areas at a

smaller unit level, hence a more focused definition of urban rural based on population density and other factors indicating the presence or absence of an urban infrastructure was used. In practice, however, one could argue that the definitions are not qualitatively discrepant, but reflect more a degree of precision. For example, it is somewhat like comparing UK counties and districts that are known to have a strong agricultural base (such as Wiltshire), with those that are clearly not (such as Greater London), and then comparing agriculturally based districts in Greater London with those that are not. One could, therefore, argue that greater precision might have been achieved in the first data pull if the exact area the offender came from was identified in terms of urban or rural, rather than the district in which the records were kept. However, identifying and processing such data was not possible within the material and time constraints of this thesis. It is, however, something to be considered in future research.

Given these limitations, clearly any results obtained should be treated with due caution, and be considered provisional until replicated; nevertheless, it can be argued that, on the whole, particularly in this context, where used, the strengths of the archival approach outweigh its disadvantages, and official police records remain the most useful tools for investigating variables relevant to understanding offender characteristics and other influences on their behaviour (Alison & Canter, 2003). Also, the data on environmental variables, though limited, represent a level of detail not yet seen in the literature; hence, though provisional, the present data could be construed as a valuable resource for informing and guiding future research. Moreover, it could reasonably be argued that if there are some general principles that influence arson rates in any given area, if they show up only with very large samples, then their practical and explanatory value is likely to be very limited.

12.2.2. Future Research

Beyond the obvious recommendation of replication with different samples measures, there are numerous suggestions that could be made for future research. A number of these have already been mentioned in the previous sections. However, two main categories of proposals stand out.

The first concerns extending the range of variables studied. Because of various practical considerations, including time and sample size, the number of variables that could be investigated was necessarily limited. This meant that some results might have not been significant because of a failure to consider a sufficient range of variables or measures; notable examples are the failure of territorial markers, and individual property variables generally. If repeated, the study could include more measures such as potential markers and/or a more thorough and detailed examination of those already identified. It was also not possible to follow up a number of potentially interesting leads; for example, to study systematically whether certain professions are overrepresented among arsonists. It would also be interesting to investigate whether different locations have different profiles of arsonists beyond the simple urban/rural distinction.

The interplay between environmental features and offence related behaviours could also be extended. For example, in the current thesis there was not time to investigate street grids and how they might influence travel distance and travel directions. It is well known that most types of offenders do not travel far from their home base (see for example, Brantingham & Brantingham, 1981; Canter & Larkin, 1993; Fritzon, 2001; Lebaeu, 1985), but travel distance still differs widely from one study to another. In an environment with many straight, parallel streets, offenders might feel the need to travel a further distance before being out of sight, whereas environments with many short, curved and cut sections might result in shorter travel distances, as it might be considered easier to lose a possible police unit in pursuit.

The other main category of proposals for further research concerns the formal or systematic investigation of motives and other hypothesised characteristics. One particular issue, identified in earlier chapters, that became very obvious to the researcher as she looked at the literature and attempted to interpret her findings, was that when attempting to make sense of the data, like most other researchers, she found it very difficult to avoid inferring motives and other characteristics to offenders to account for why they behaved as they did (i.e. acted as solo offenders, serial offenders, used accelerants, brought other materials to the scene, fired schools but not vehicles, and so on). However, despite the researcher's attempts to use the available literature to provide explanations, in the vast majority of cases (and as in many previous studies), without follow up information, these interpretations could be considered little more than 'informed speculation'. Of course, as mentioned on a number of occasions, one could argue that one does not actually need such interpretations to make sense of the data; the data could be construed as 'standing as they are'. However, it would clearly be of considerable psychological interest to find out more about how offenders view their behaviour and what motivates it. Why did these particular offenders choose arson, and not another possible route (legal or illegal)? And why did they select these particular targets and methods? Ideally, therefore, it would seem potentially very useful to follow up at least some of the offenders identified in the various analyses, perhaps using qualitative inquiry, to establish whether their perception and experience of their actions in any way reflects the kinds of interpretation placed on it by the present and previous researchers.

Take, for example, the predictors of serial offending (and potentially recidivism). As mentioned, demographic factors were found to be the best predictors, in particular, being male, an urban offender, having convictions excluding arson, not being enrolled in school and not doing manual work at the time of offending. In response, the researcher made various speculative statements by way of explanation, but these must obviously remain conjecture

until individuals in such categories can be identified and investigated using a more detailed inquiry. Another obvious example of this concerns the gender imbalance between male and female arsonists, and the different age profile of female arsonists in the present studies. Thus, if, as speculated, it is the case that females are more likely to commit arson, particularly at a later age, because of a reaction to family dysfunction, it would seem important to have direct evidence for this from the sample concerned (for example, by interviewing them and others, and investigating fully their domestic circumstances).

This kind of more detailed inquiry could also be extended to an investigation of the victims of arson, which is another area of investigation that is currently severely lacking in the literature on arson.

12.3. Implications of the Current Research

12.3.1. Theoretical Implications

As emphasised on a number of occasions throughout this thesis, including in this chapter, a guiding principle underlying the methodology used was to avoid attempting to group variables into a few global factors or clusters and attempting to assess or predict relationships between them. As a number of authorities have recognised, such an approach seems to introduce an unnecessary level of subjectivity and groupings and labelling often show poor consistency and reliability and are open to different interpretations, (see Gannon & Pina, 2010). Added to this, because the whole point of such a global approach is to collapse or reduce large amounts of data to a only few units or factors, the resulting constructs lack precision in capturing details of wide range of behaviours across a number of situations, and, therefore, have relatively poor predictive value, especially if they are to have any application to actual forensic situations (see Alison, Bennell, Mokros, & Ormerod, 2002; Alison, West, & Goodwill, 2004; Goodwill et al., 2009; Woodhams & Toye, 2007).

Consequently, in line with the approach advocated by Goodwill et al. (2009), the main emphasis in the present thesis was not on imposing some kind of global theoretical structure or model on the results, but simply on gathering as much summary data as possible about the individual variables from the information available so they might potentially be of use to other investigators. Indeed, one of the striking features of the present results is how difficult they are to map directly onto any of the theories of arson described in Chapter 2. For example, to the best of the researcher's knowledge, the three categories of offender loosely identified earlier from the demographic findings (i.e. the more frequent opportunistic arsonist; the less frequent, but more serious, often more persistent serial offender, and the older mainly female arsonist who has mental health issues), have not been suggested or explored in the literature, theoretically or empirically, the main reason being that, as yet, the range of variables covered in the present thesis has not been covered simultaneously.

Similarly, as suggested in Chapters 8 and 9, if one wanted to impose some kind of general patterns on the offence related findings, Inciardi's (1970) rather old classification of arson offenders as 'revenge arsonists', 'excitement arsonists', 'insurance claim arsonists', 'vandalism offenders' and 'crime concealers', seems to be as good as any as a way of describing some of the main patterns in the data. However, once again, it is difficult to see how any such simplified theoretical scheme or model scheme could meaningfully capture the diversity of findings shown in the present studies, especially when we try to map these onto the demographic and biographical variables. Indeed, perhaps what table 12.1 tells us more than anything is that, whilst one can attempt to impose certain interpretational patterns on the data, the fact remains most offence related behaviours have multiple causes and may be committed by different categories of offenders for different reasons. One is reminded here, perhaps, of Kusche's (1975) conclusion regarding his investigation of disappearances in the the infamous 'Bermuda Triangle'. He says: "My research, which began as an attempt to find

as much information as possible about the Bermuda Triangle, had an unexpected result. After examining all of the evidence I have reached the following conclusion: *there is no theory that solves the mystery*.... By abandoning the search for an overall theory and investigating each incident independently, the mystery began to unravel (p.251).

Consequently, in the same way, if there is a primary theoretical implication of the present findings, it is that, in terms of accuracy and for practical purposes, there may be merit in adopting an approach to data interpretation that describes and interprets individual findings without attempting to incorporate them into some grand model or scheme. From this perspective, therefore, perhaps the best schematic way of summarising and presenting the present findings is simply in terms of the three summary tables, 12.1, 12.2 and 12.3.

Having said this, the findings for the environmental variables would appear to endorse this researcher's view that, collectively, Defensible Space Theory, CPTED (Crime Prevention Through Environmental Design) and Incivility Theory (see Chapters 3 and 11) may provide provide a rich source of ideas and interpretational sets for describing the and understanding the influence of environmental effects on arson behaviours.

12.3.2. Methodological Implications

In light of the above, perhaps the most important methodological implication of the present studies is that, when studying arson (or any other area of criminal behaviour) researchers should examine as wide a range of potentially relevant variables as possible. As previously summarised, although a number of predictions could be construed as in line with previous studies (particularly those involving basic demographic variables such as age and gender), a number were not (particularly some of the environmental variables), and others had not previously been investigated. As has been mentioned a number of times, the reasons for this are, as yet, unclear. Hence, they may variously reflect inadequacies in measurement and/or

sampling in the methods used in this thesis, or idiosyncrasies of the present (Danish) sample. However, it could also be reasonably argued that they may highlight some of the methodological inadequacies in previous studies that have not used the range of variables or investigated here, and, as a consequence, have often produced ambiguous and conflicting results. To the best of the researcher's knowledge, consideration of this particular range of demographic, offence related and environmental variables, on a sample of this size, is unique and goes beyond previous studies. For example, in their regression studies, Edwards and Grace (2014) did not look at crime scene behaviours or environmental variables, whilst Santilla et al. (2004) used only 42 offenders, included only a couple of demographic variables, and did not include environmental variables.

Relatedly, another notable methodological implication that emerges from a number of the present analyses is that simple zero-order associations, frequently reported in previous studies, may often oversimplify the relationships between crime related variables, suggesting that relationships between some variables may be more complex than previously thought and may not necessarily operate through the processes hypothesised in the literature. With regard to arson specifically, the importance of including a range of very obvious environmental variables, such as distance of targets from the nearest police station, is clearly something to be stressed in future research on arson.

The methods employed in the present studies also potentially allow us to assess the relative influence of demographic and offence related behaviours in a way not possible unless these types of variables are considered simultaneously on a reasonable large scale, thereby allowing comparisons across categories. As an example of this, the summary AUC values taken from Studies 3 and 4 are presented in Table 12.4. If one examines this table, the results show something long known and commonly found in the literature on individual differences; i.e. variables predict other variables better if they come from the same conceptual and

situational domain (see, for example, Hartshorne & May, 1928; Mischel, 1968). And, accordingly, on balance, when offence/crime scene related variables were the dependent variables, the AUC values were higher when the other offence related characteristics were entered as predictors, than when the demographic and biographical variables were entered as predictors. Indeed, the difference between the two sets of values was significant by Wilcoxon test ($z = 2.11, p = .035$). Though, by the same token, the demographic variables seemed to do marginally better in relation to those offence related dependent variables that might be considered to reflect a greater influence of ‘personal’ factors, such as targeting oneself or own home and the use of alcohol.

*Table 12.4: AUC Values for Predicting offence Related Variables from other Offence Related Characteristics and Demographic and Biographical Variables (where entered, all AUC values $p < .0001$; * Overall model not-significant).*

	Predictors		
	Offence Behaviours	Demographic /Biographical	Difference
Target Residential	.87	.77	0.10
Target Business	n.s.*	.68	-
Target School	.84	.84	0.00
Target Public Building	.69	.81	-0.12
Target Vehicle	.92	.84	0.91
Target Miscellaneous	.82	.73	0.09
Target Self	.92	.95	-0.03
Target Own Home	.86	.88	-0.02
Multiple Items Fired	.92	.72	0.20
Arson Planned	.83	.71	0.12
Solo/Group Offender	.87	.86	0.01
Multiple Fire Sites Fired	.85	.73	0.12
Accelerant Used	.82	.72	0.10
Material Brought to Scene	.82	.71	0.11
Offender Gave Alert	.77	.76	0.01
Offender Remained	.84	.75	0.09
Alcohol Used	.81	.87	-0.06
Travel Under/Over 0km	.96	.79	0.17
Travel Under/Over 5km	.74	.77	-0.03

Using the same rationale, one might expect previous arson/recidivism, which is essentially a biographical feature, to be best predicted by other demographic and biographical variables, and this was well illustrated in Study 5 where the AUC value for demographic and biographical factors model was classed as ‘excellent’ whereas that for offence related variables was classed as ‘poor’. Indeed, as evidenced by the 95% confidence intervals, the AUC for the offence related variables (CI = .64-.76) was significantly poorer than that for the demographic variables (CI = .78-.88).

Taken together, therefore, offence related or crime scene variables were, on the whole, better predicted by other crime scene variables; but, perhaps the most important, the biographical variable, previous convictions, was clearly better predicted by other demographic variables. This may potentially be a really important finding as it illustrates a reason why offender profiling is so difficult to do. In offender profiling, investigators most often attempt to generalise from crime scene behaviours to demographic variables (the ‘homology’ assumption). However, the present results imply that, whilst one may be able to predict crime scene behaviours from other crime scene behaviours with some degree of accuracy, and, similarly, demographic behaviours (like previous arson) from other demographic factors, predicting crime scene behaviours from demographic factors and vice versa may be considerably more difficult.

To the best of the researcher’s knowledge, this is the first study of its kind on arson to make this observation as previous studies have not investigated a sufficient range of variables to make this kind of direct comparison possible. Moreover, once again, these findings could be construed as a vindication of the overall approach adopted in this thesis; i.e. if an attempt had been made to collapse all the data into a few categories, based and interpreted using some kind of broad abstract theoretical framework, this distinction could easily have been overlooked.

12.3.3. Practical Implications and Applications

Although, hopefully, the present results could be considered to inform the literature on arson, given the limitations of the sample and the methodology, it would be inappropriate for the researcher to suggest that, as they stand, the results are sufficiently reliable or valid to have immediate and direct implications for Police practice or policy with regard to the prediction and control of arson, as to do so would most certainly be ‘going beyond the data’.

Nevertheless, if extended and shown to be repeatable, one could conceive of ways in which they might have practical implications; but, even then it is important to understand the limitations of the approach adopted. For example, one might reasonably ask, assuming they can be replicated and generalised to other samples, could the present regression results, as summarised in the tables in this chapter, be used by the Police as a basis for a potential practical ‘profiling’ scheme for arsonists, giving possible directions for ‘suspect prioritisation’?

12.3.3.1. Interpreting the Tables: On first consideration, this might seem a reasonable question as some investigators have used similar regression methodologies to argue for exactly this outcome (see, for example, Fujita et al., 2012). However, the use of crime scene variables to ‘profile’ and identify possible offenders is an issue that has created considerable controversy in the literature (see, for example, Alison, Bennell, Mokros, & Ormerod, 2002; Almond, Alison & Porter, 2007; Mokros & Alison, 2002; Wilson & Alison, 2005; Woodhams & Toye, 2007). A major problem is that, even when profiles of crime scene variables derived using fairly sophisticated statistical techniques are shown to be internally consistent or reliable, the ‘homology’ assumption, i.e. the assumption that one can accurately predict or profile the demographic characteristics of offenders from crime scene variables, has received little if any empirical support (Mokros & Alison, 2002; Woodhams & Toye,

2007). In many respects the present results could be considered to illustrate well some of the issues involved.

Fundamental to an assessment of any kind of multivariate procedure involving correlations or statistical associations in terms of practical decision making, such identifying or profiling potential suspects, is an understanding of exactly what the results mean (and what they do not). Take, for example, the following typical statement from Fujita et al. (2012) that interprets the results of a set of binary logistic regression models estimating whether crime scene offences predicted single or group offending: “Stepwise selection of a multivariate logistic model for predicting offenders belonging to organised crime identified nine crime scene variables. Among these variables, homicide cases in which victims were shot by firearms were 7.12 times more likely to be committed by members of organised crime ($OR = 7.12$)” (p. 221). On the basis of data such as these, Fujita et al. (2012) conclude: “In the early stage of homicide investigation, the adjusted OR values of crime scene variables could be used as direct cues to infer homicide offender characteristics” (p.225). However, this interpretation can easily be misunderstood. In the above case, because homicides in which victims were shot were 7.12 times more likely to be found amongst members of organised crime, it does not follow that any particular shooting case would most likely have been the work of members of organised crime. This is because, in regression statistics, Odds Ratios are exactly that, relative odds, whereas statements about whether any particular event would actually have been committed by a particular class of offender are crucially influenced by the number of, or base rate for, such offenders in the population.

To illustrate the issue, consider the association between gender and deliberately endangering lives in the present sample (see Table 13.2). If we apply a simple zero-order binary logistic regression to these data, regardless of whether we use gender as the dependent variable and lives endangered as the independent variable, or vice versa, the result is the

same: one significantly predicts the other ($p < .0001$) with an odds ratio of $1/\text{Exp}(B) = 5.35$. Hence, as can be seen from Table 13.2, in terms of relative odds, the females in the sample were 5.35 times more likely to endanger lives; or alternatively, endangering lives was 5.35 times more likely to occur among the females in the sample (i.e. $37/17$ is 5.35 times greater than $87/214$, and $37/87$ is 5.35 times greater than $17/214$; for odds ratio calculation methods in logistic regression, see, UCLA, 2017).

Table 12.5: Gender x Lives Endangered Deliberately Frequencies

		No Lives Endangered	Lives Endangered	Total
Gender	Female	17	37	54
	Male	214	87	301
Total		231	124	355

However, whilst the findings do appear to identify being female as a ‘risk factor’ in endangering lives in arson attacks (and cases of endangering lives are relatively more likely to be found among females), they do not enable us to infer that if we are presented with an arson case where lives have been endangered deliberately, it was most likely committed by a female. In fact, as also shown in 12.1, there were significantly more males (301) than females (54) in the sample; as a consequence, it remained the case that, if a particular offence endangered lives, *it was still more likely to have been committed by a male*; indeed, a Binomial Test between the frequencies for males (87) and females (37) for lives endangered was highly significant in this respect, $p < .0001$.

Consider an analogy: if we assume that 17 year old drivers are far more at risk for road accidents than older groups of drivers, we could reasonably state that 17 year olds are relatively more likely to be involved in road accidents, and road accidents are relatively more likely to occur among 17 year olds. However, on the balance of probability, given how few

17 year old drivers there are on the road relative to drivers over 17, it would be a mistake to assume that any particular accident most likely involved a 17 year old.

It should also be emphasised that this principle applies to any multivariate statistical offender profiling procedure that is based on correlations or regressions. Thus although multivariate statistical procedures that rely on correlational or regression procedures may potentially enhance our understanding of the nature of crimes and offenders, and provide indicators of possible risk factors in predicting offending behaviours, it does not follow that they enable us to work directly ‘backwards’ from crime scene behaviours in individual cases to predict offender characteristics, other than in a very general way, i.e. pointing perhaps to characteristics of offenders that we might wish to consider more in some cases or situations than others. For example, in a case where lives are endangered, rather than assuming from the OR statistic that the perpetrator is likely to be female, we might simply wish to pay more attention to this possibility when considering such cases compared to others.

With this in mind, it could be proposed that the most appropriate way of interpreting regression summary tables such as those included here, is in terms of identifying the kind of offender who is most likely to perform the behaviour identified in the dependent or criterion variable column. In other words, the question we could most reasonably attempt to address using such tables is “what kind of person is most at risk for performing a particular type of action X?”, rather than ‘given an offence of type ‘X’, what kind of person is most likely to have committed it?’

An example of how Table 12.1 might be interpreted in this way, therefore, might be to say that the kind of person most at risk for targeting residential properties would be a an older female with a history of alcoholism who operates alone, fires multiple sites, endangers lives, targets an ex-partner, and gives an alert during or after the fire. The relative importance or weighting of each of these characteristics in determining risk can then be estimated by the

respective odds ratios (ORs). It would be very important to remember, however, that the likelihood that any particular fire was set by such a person would very much depend on the number of such individuals who exist in the population compared to those who also set fires to residential properties but are at lower risk.

12.3.3.2. Further Implications for Police Policy and Practice: Given all this, if shown to be valid and generalisable, one could conclude perhaps that the present results as summarised in the tables in this chapter, might be more relevant to the Police and other authorities as an aid to *arson prevention* rather than offender profiling or suspect prioritisation i.e. the results in Table 12.1 suggest that different types of arson may be related to different demographic and offence related characteristics, and potentially could indicate which types of individuals are most vulnerable to be at risk for certain kinds of arson behaviours. Similarly, Table 12.2 summarises the characteristics of those arsonists likely to reoffend, and Table 12.3 summarises the environmental variables most likely influence the presence of arson in a particular area. However, in terms of practical implications, a number of key findings would appear to stand out.

For example, the most common arsonist in this sample was by far the typical young male offender, who may have been out for excitement, or sensation seeking, or exhibiting machismo prowess, and setting fire as part of a group. When targeting this type of offender, therefore, such as in schools, Police educators and policy makers could stress the importance for young males of having access to other more constructive activities that might satisfy these motives. However, the present results also suggest that by concentrating on schools, both investigators and educators may be missing a more serious type of repeat offender who may be of school age but not attending school. In fact, given the significance of the variable ‘not enrolled in school’ in a number of the present studies, the need to identify groups of offenders

who are of school age, but not in school, would seem to be particularly important. The police in their everyday work could perhaps be made especially aware of this subgroup of offenders, as if spotted and/or apprehended, they might at this stage still be young enough to be influenced in a more positive direction. More research into the motivations behind this particular category of firesetters and possible schemes to redirect them, might prove particularly worthwhile.

Another important finding in the present findings concerned female arsonists, and particularly their bimodal age profile. For example, although in the minority of arson offenders, from an investigative viewpoint, the results suggest that, if there is a residential fire, investigators need to be more aware of a possible female firesetter, operating alone, including the possibility that she may be older than might be expected. Also, the present results showed that female firesetters were more likely to have mental health issues, including depression or suicidal tendencies, and other factors leading to *dysfunction in their own homes* (marital issues, child care issues, etc.). In terms of prioritising, therefore, although, most arsonists appear to be younger males, any programmes designed to combat arson should also be addressed to females also, but with a different emphasis; hence rather than suggesting alternative activities, programmes for females should consider counselling and advice regarding personal and family issues, including special provision for older women.

With regard to the environmental variables, key results included the findings that vacant buildings were more likely to be targeted; a finding that could be considered useful both to Police and policy makers who could target such areas in terms of surveillance and planning. Also although building density also predicted significantly it did so, in the opposite direction to that predicted: i.e. higher building density was associated with lower arson rates. It was argued that the latter might have been because of reduced because of greater

opportunities for surveillance. This again emphasises the importance of providing evidence of surveillance as a method of arson prevention.

However, perhaps the most salient finding was the ubiquitous presence of distance from the nearest police station in predicting arson rates. As noted in Chapter 11, it appears that, in predicting arson rates, this mediated and/or outperformed a number of the more standard or classic variables, such as high rise building, population density and (lack of) territorial behaviours. In terms of planning new facilities, or targeting areas for general policing, therefore, policy makers could be made aware of this.

12.4. Overall Conclusion

By way of a final conclusion to this thesis, it may be worth emphasising that if the aim of arson research is ultimately to enable those making policy to efficiently target those factors particularly likely to influence arson rates, the present results could be construed as suggesting that much, or possibly the vast majority of arson research, may not have been best directed. As is evident from the literature review in this thesis, the overwhelming emphasis in the literature has been in attempting to categorise and profile arsonists and their behaviours, rather than examine the situational influences on their behaviour. This is despite the fact, well documented in the different individual literature, that predicting behaviours in particular situations from the characteristics of individuals is a notoriously difficult exercise (Hough & Oswald, 2000; Mischel, 1968; Shoda, Mischel, & Wright, 1994). In this respect, therefore, if extended and replicated, the present results could potentially have two important implications.

First, as mentioned above, whilst one may be able to predict crime scene behaviours from other crime scene behaviours with some degree of accuracy, and, similarly, demographic behaviours (like previous arson) from other demographic factors, predicting

crime scene behaviours from demographic factors and vice versa may be considerably more difficult. Second, and in contrast, in terms of having maximum impact on arson rates, perhaps too little attention has been paid to the kinds of environmental variables considered in Chapter 11. Although the results were not entirely as expected, the ‘excellent’ AUC value for the environmental unit variables (.87) showed that these kinds of variables did a relatively good job of predicting the presence of arson. Hence, as first mooted by researchers such as Bennett et al. (1987), an extension of this approach could potentially be used for developing environmental schemes for arson prevention that might be considerably easier to apply, and perhaps even more effective, in preventing and reducing arson than attempting to target ‘at risk’ groups of individuals.

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Appendices

APPENDIX 1

Demographical and Biographical Variable Coding Dictionary		
Variable	Coding	Total <i>N</i>
Gender	Offender gender was coded as male (<i>n</i> = 470) or female (<i>n</i> = 70)	540
Age	The age of offenders at the time of their first offence was used to measure age.	540
Urban/Rural	Offenders were coded as Urban (<i>n</i> = 283) or Rural (<i>n</i> = 257) according to where their records were kept in individual police stations.	540
Single/SerialOffending	Offenders were coded as single arsonists (<i>n</i> = 445), if they had been reported as offending on only one occasion, and serial arsonists (<i>n</i> = 95) if they had set fires on two or more separate occasions.	540
Psychiatric History	Offenders were coded as having a psychiatric history (<i>n</i> = 79) if on their record it was stated that they had been diagnosed with a disorder and/or had had continued contact with a mental health professional at the time of any of their offences, and not having a psychiatric history (<i>n</i> = 276) if this was not the case.	355
Depression	Offenders were coded as having depression (<i>n</i> = 35) if on their record it was stated that they had been diagnosed with a depression by a mental health professional at the time of any, and not having a depression (<i>n</i> = 276) if this was not the case.	355
Psychosis	Offenders were coded as having a psychosis (<i>n</i> = 28) if on their record it was stated that they had been diagnosed with a psychosis by a mental health professional at the time, and not having a psychosis (<i>n</i> = 327) if that was not the case.	355

Personality Disorder	Offenders were coded as having a personality disorder ($n = 23$) if on their record it was stated that they had been diagnosed with a personality disorder by a mental health professional at the time, and not having a personality disorder ($n = 332$) if that was not the case.	355
Suicide	Offenders were coded as having attempted suicide ($n = 28$) if such an attempt was stated on their at any point in time, and not having attempted suicide ($n = 327$) if that was not the case.	355
Alcohol	Offenders were coded as having alcohol abuse issues ($n = 68$) if on their record it was stated that they had long term problems with alcohol, and not having alcohol abuse issues ($n = 287$) if that was not the case.	355
Criminal History	Offenders were coded as having previous convictions ($n = 179$) if on their record it was stated that they had previously been convicted of any type of crime, and not having previous convictions ($n = 176$) if this was not the case.	355
Convictions excluding arson	Offenders were coded as having convictions other than arson ($n = 126$) if on their record it was stated that they had any other type of conviction except arson, and not having convictions excluding arson ($n = 229$) if this was not the case.	355
Arson	Offenders were coded as arson ($n = 100$) if on their record it was stated that they had set fire previous to their current crime, and not having previously set fire ($n = 255$) if this was not the case.	355
Theft	Offenders were coded as theft ($n = 76$) if on their record it was stated that they had previous convictions of theft, and not having previously committed theft ($n = 279$) if this was not the case.	355
Burglary	Offenders were coded as burglary ($n = 40$) if on their record it was stated that they had previous convictions of burglary, and not having previously committed burglary ($n = 215$) if this was not the case.	355

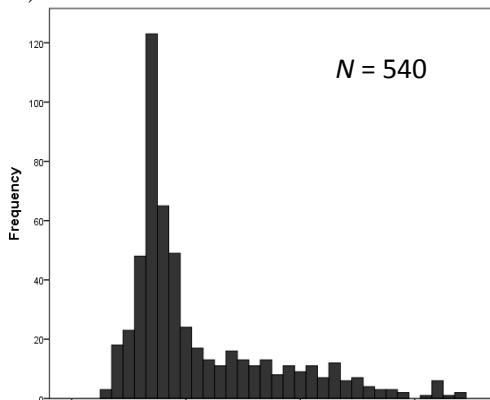
TWOC	Offenders were coded as TWOC ($n = 31$) if on their record it was stated that they had previous convictions of TWOC (taking without owners consent. Usually theft of car or vehicle), and not having previously committed TWOC ($n = 224$) if this was not the case.	355
Traffic	Offenders were coded as traffic ($n = 34$) if on their record it was stated that they had previous convictions of any sorts of traffic violations, and not having previously committed traffic violations ($n = 321$) if this was not the case.	355
Drugs	Offenders were coded as burglary ($n = 27$) if on their record it was stated that they had previous convictions of any type of drug violation (distributing, drug trafficking, etc.), and not having previously committed drug related crimes ($n = 328$) if this was not the case.	27
Criminal Damage	Offenders were coded as criminal damage (arson, forced entry, graffiti, etc.) ($n = 41$) if on their record it was stated that they had previous convictions of criminal damage, and not having previously committed criminal damage ($n = 314$) if this was not the case.	355
Assault	Offenders were coded as assault ($n = 33$) if on their record it was stated that they had previous convictions of assault, and not having previously committed assault ($n = 322$) if this was not the case.	355
Public Disorder	Offenders were coded as public disorder (threatening, abusive or insulting behaviour in a public place, etc.) ($n = 28$) if on their record it was stated that they had previous convictions of public disorder, and not having previously committed burglary ($n = 327$) if this was not the case.	355
Deception	Offenders were coded as assault (fraud, identity theft, etc.) ($n = 22$) if on their record it was stated that they had previous convictions of deception, and not having previously committed deception crime ($n = 333$) if this was not the case.	355

Higher Qualifications	Offenders were coded as higher qualifications ($n = 15$) if on their record it was stated that they had any higher qualifications, and not having any higher qualifications ($n = 340$) if this was not the case.	355
Still at school	Offenders were coded as still at school ($n = 197$) if on their record it was stated that they were still attending school, and not still attending school ($n = 158$) if this was not the case.	355
Living with parents	Offenders were coded as living with parents ($n = 208$) if on their record it was stated that they had lived with their parents at the time of the crime, and not living with parents ($n = 147$) if this was not the case.	355
Trouble at School	Offenders were coded as trouble at school ($n = 48$) if on their record it was stated that they had a history of behavioural or academic issues at school, ($n = 307$) if this was not the case.	355
Institution	Offenders were coded as institution ($n = 39$) if on their record it was stated that they had any time lived at an institution (orphanage, special needs Home, psychiatric institution, residential care, etc.), and not having any higher qualifications ($n = 316$) if this was not the case.	355
Recently Divorced	Offenders were coded as recently divorced ($n = 19$) if on their record it was stated that they had divorced within the last six months of their most present criminal behaviour, and not having recently divorced ($n = 336$) if this was not the case.	355
Unemployed	Offenders were coded as unemployed (258) if they had been unemployed at the time of any of their offences, and employed ($n = 97$) if they had never been unemployed at the time of any of their offences.	355
Danish Nationality	Offenders were coded as Danish nationality ($n = 304$) if on their record it was stated that they were of Danish nationality, and not of Danish nationality ($n = 51$) if this was not the case.	355

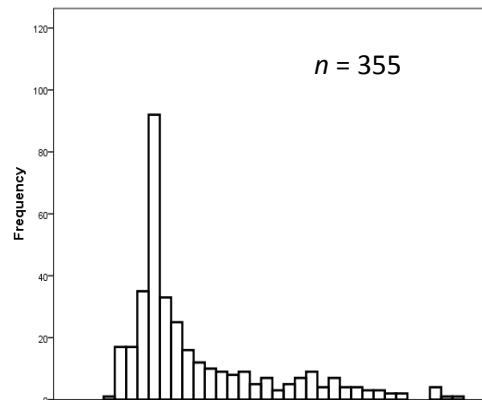
Ethnicity	Offenders were coded white ($n = 315$) as according to the British Police Identity Codes: IC1 Northern European and IC2 South European, and non-white ($n = 40$) if this was not the case.	355
Solo/Group Offender	Offenders were coded as solo offenders ($n = 156$) if all of their arson records indicated that they had acted alone and group offenders ($n = 199$) if they at any point had offended with others.	355

APPENDIX 2:

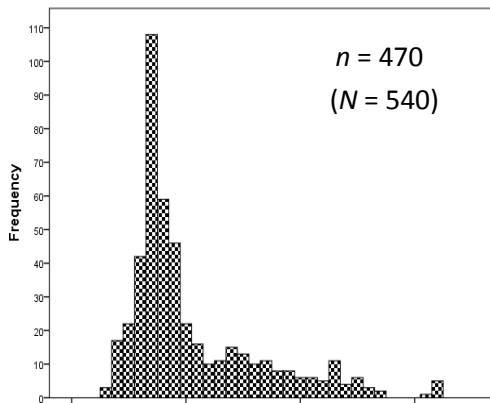
Figure 6.1: Frequency distributions for Age by Gender (for x axis ranges see Table 6.1 page 89)



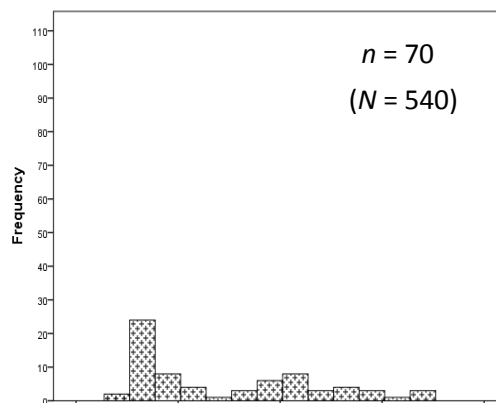
6.1a: Age of Offenders:
N = 540 sample



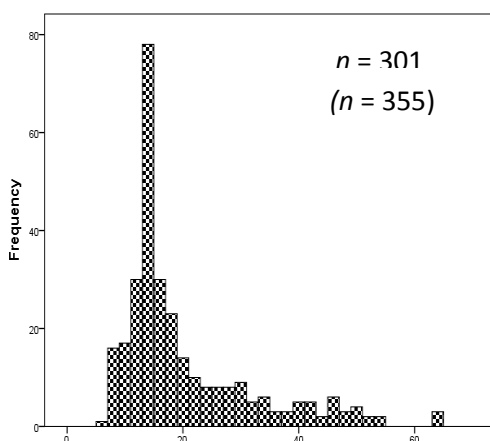
6.1b: Age of Offenders:
N = 355 sample



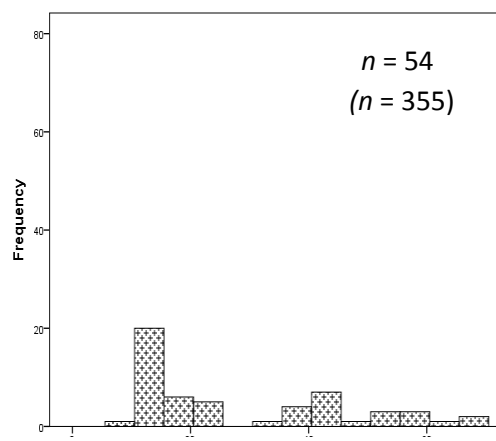
6.1c: Age of Male Offenders:
N = 540 sample



N = 540 sample

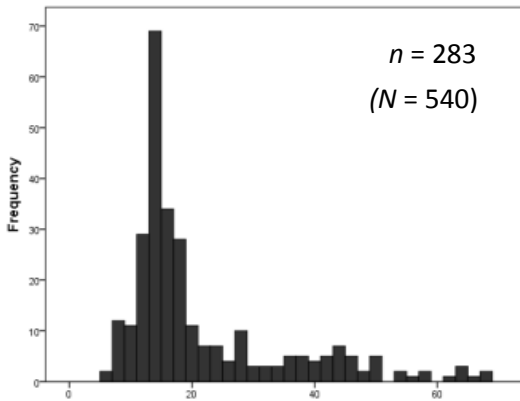


6.1e: Age of Male Offenders:
N = 355 sample

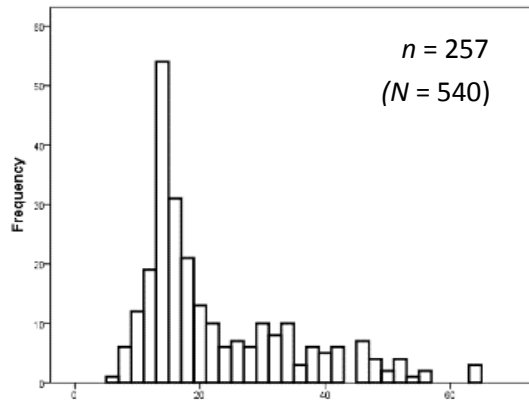


6.1f: Age of Female Offenders:
N = 355 sample

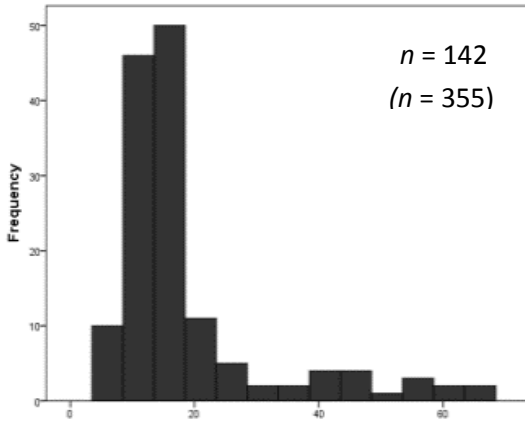
Figure 6.2: Frequency distributions by Gender and Urban and Rural districts (for x axis ranges see Table 6.2 page 91)



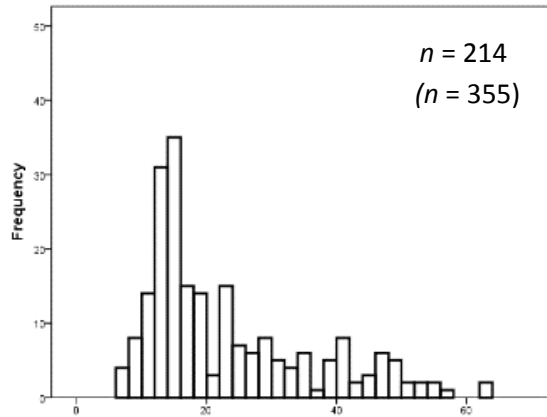
6.2a: Age of Urban Offenders:
N = 540



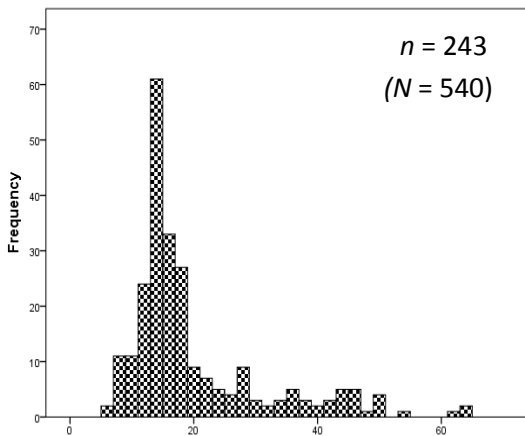
6.2b: Age of Rural Offenders:
N = 540



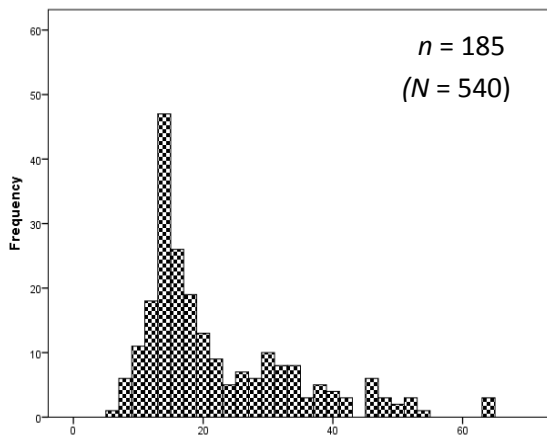
6.2c: Age of Urban Offenders:
n = 355



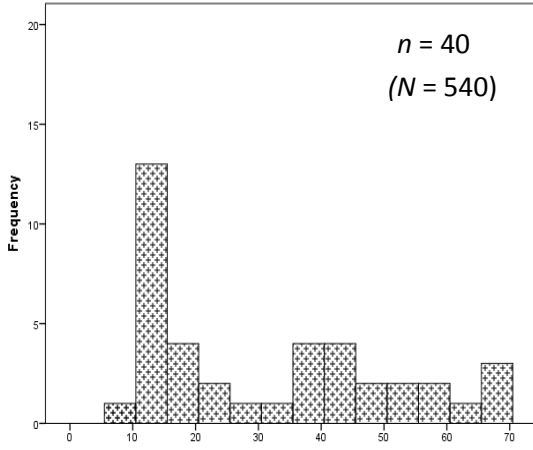
6.2d: Age of Rural Offenders:
n = 355



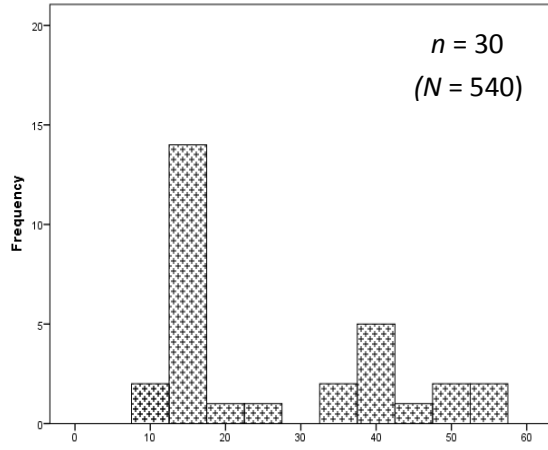
6.2e: Age of Male
Urban Offenders:
N = 540



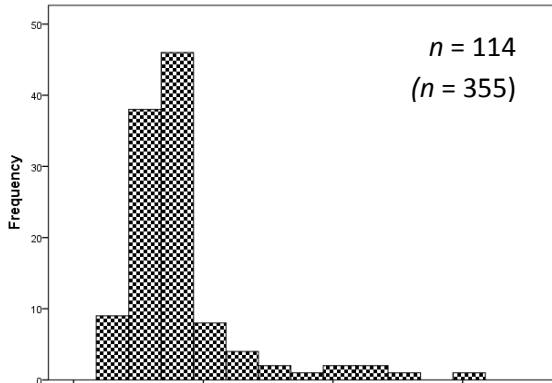
6.2f: Age of Male
Rural Offenders:
N = 540



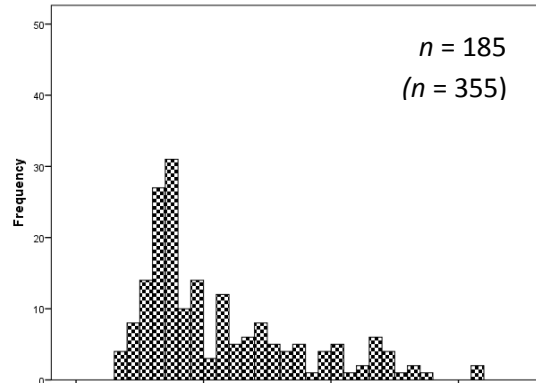
6.2g: Age of Female Urban Offenders:
N = 540



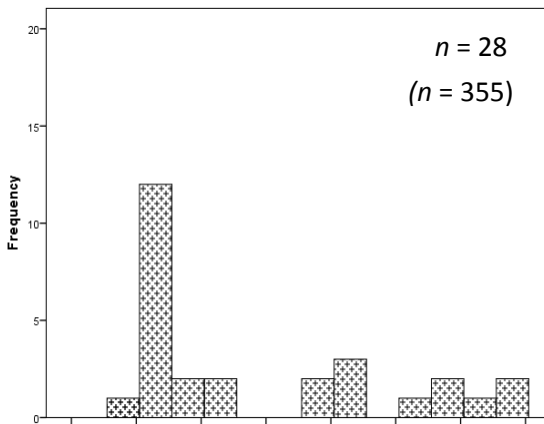
6.2h: Age of Female Rural Offenders:
N = 540



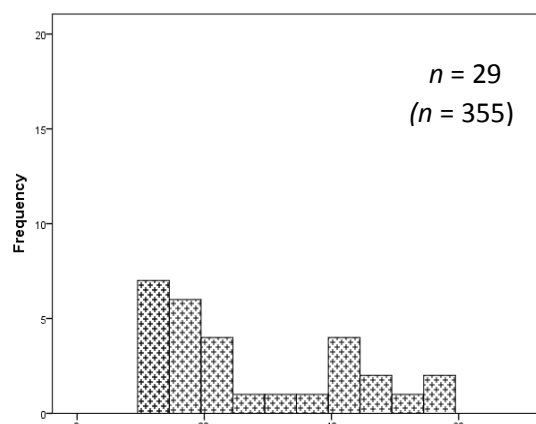
6.2i: Age of Male Urban Offenders:
n = 355



6.2j: Age of Male Rural Offenders:
n = 355



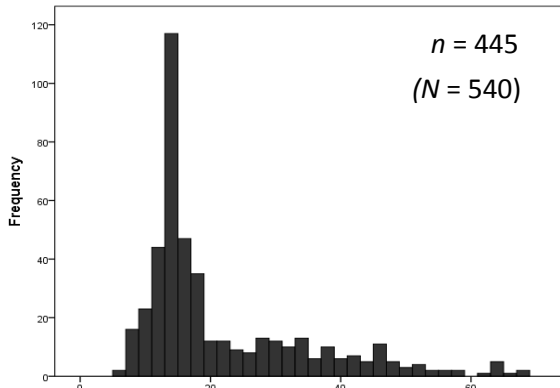
6.2k: Age of Female Urban Offenders:
n = 355



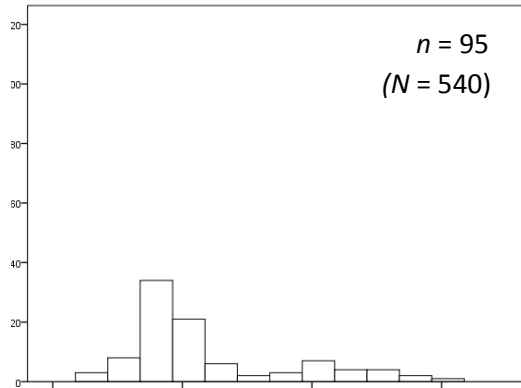
6.2l: Age of Female Rural Offenders:
n = 355

APPENDIX 3:

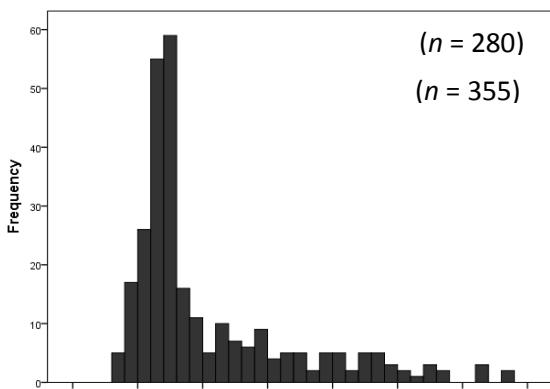
Figure 6.3: Frequency distributions by Gender and Single and Serial Offenders (for x axis ranges see Table 6.3 page 94)



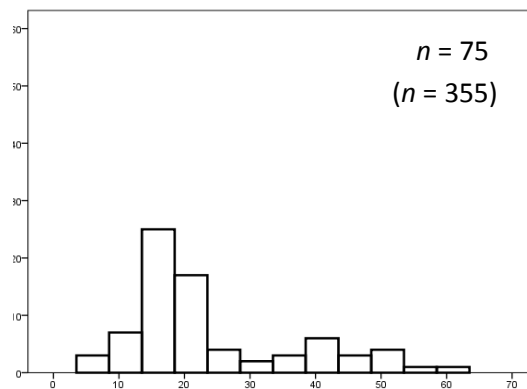
6.3a: Age of Single Offenders:
N = 540



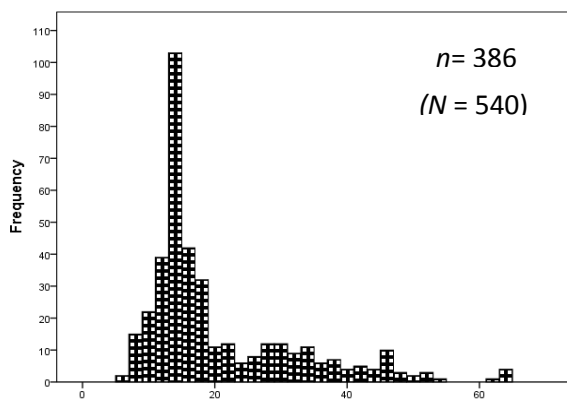
6.3b: Age of Serial Offenders:
N = 540



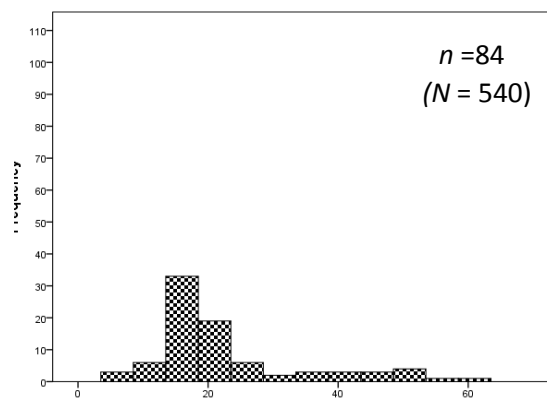
6.3c: Age of Single Offenders:
n = 355



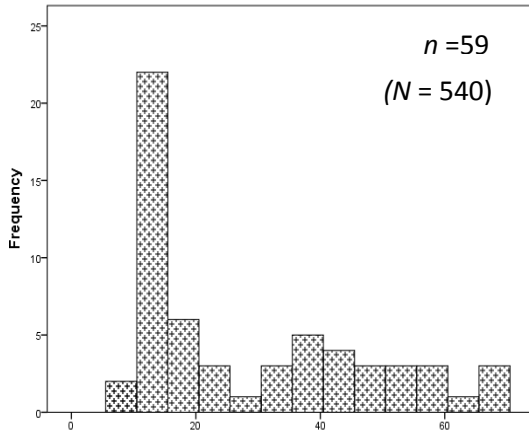
6.3d: Age of Serial Offenders:
n = 355



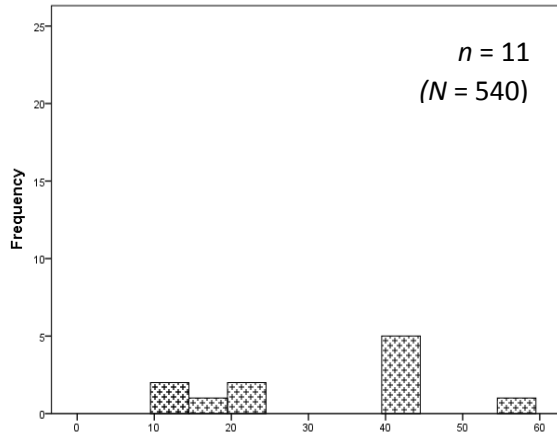
6.3e: Age of Single Male Offenders:
N = 540



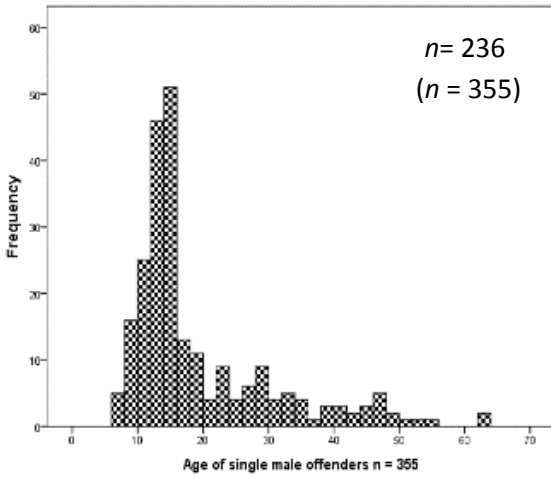
6.3f: Age of Serial Male Offenders:
N = 540



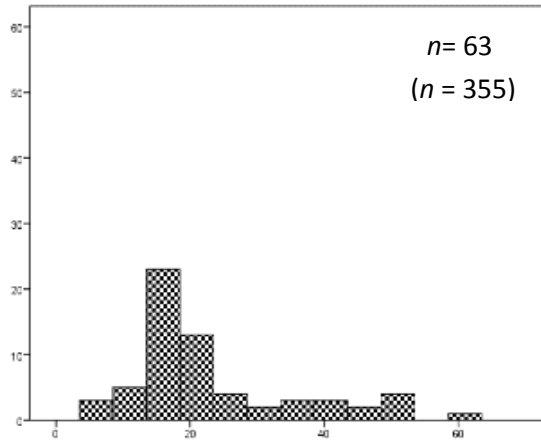
6.3g: Age of Single Female Offenders:
N = 540



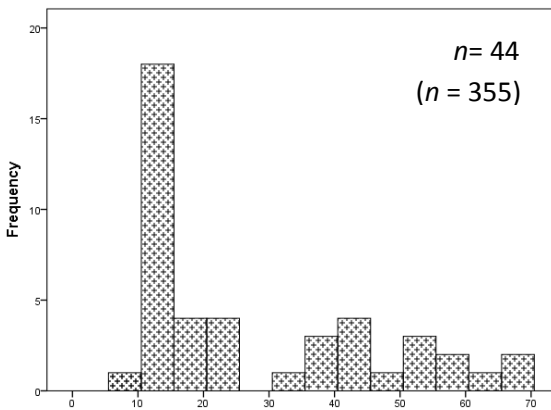
6.3h: Age of Serial Female Offenders:
N = 540



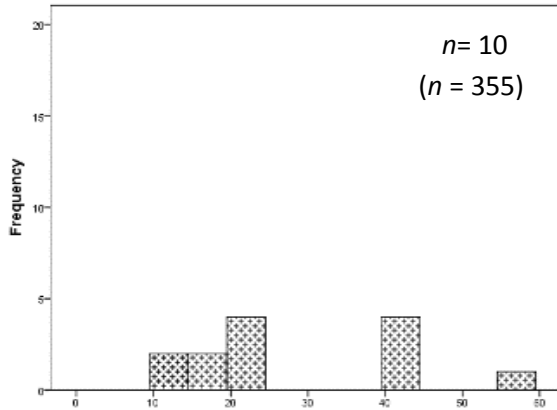
5.3i: Age of Single Male Offenders:
n = 355



5.3j: Age of Serial Male Offenders:
n = 355



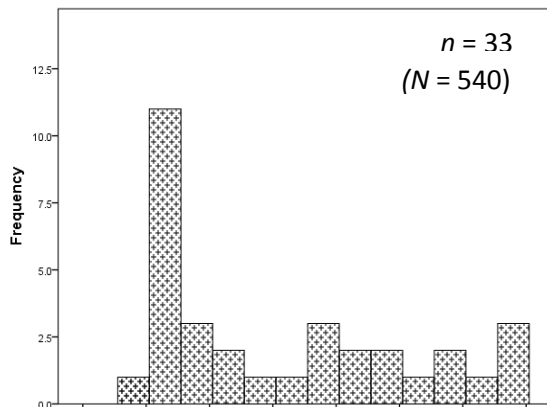
5.3k: Age of Single Female Offenders:
n = 355



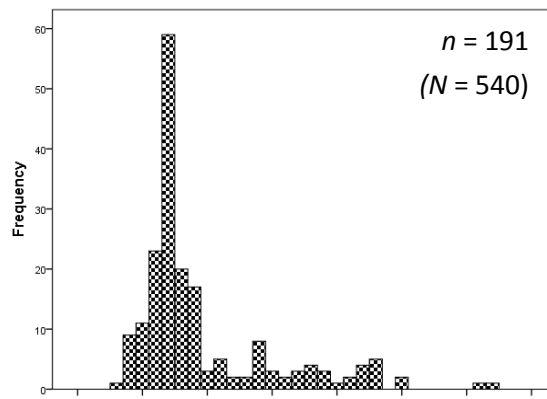
5.3l: Age of Serial Female Offenders:
n = 355

APPENDIX 4:

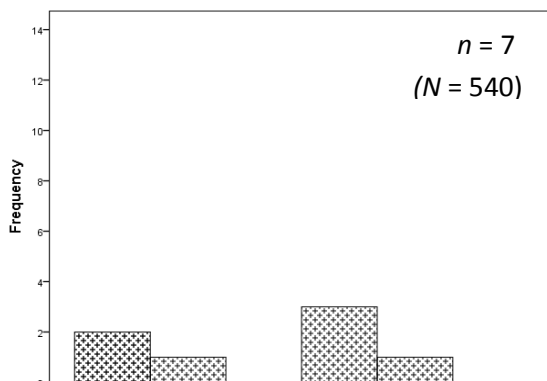
Descriptive Statistics for Gender and Age of Urban and Rural Single and Serial Offenders



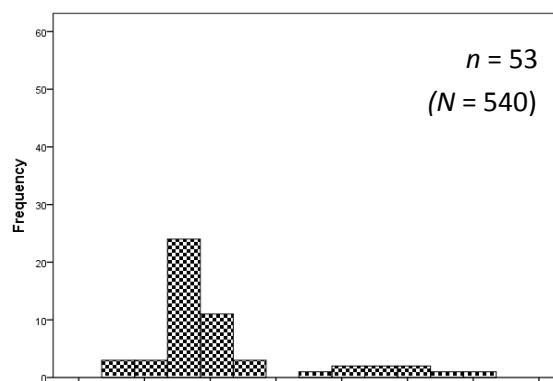
A: Urban Single Female Offenders:
N = 540



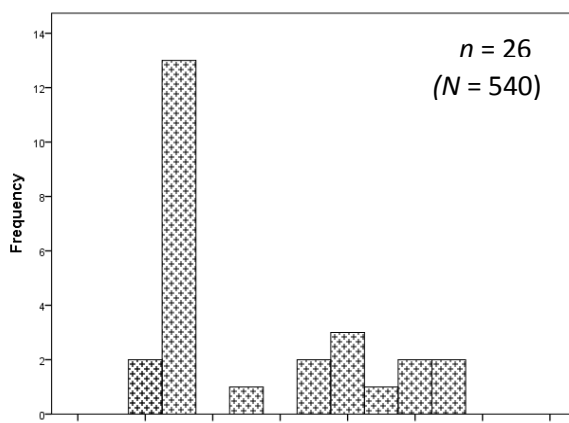
B: Urban Single Male Offenders:
N = 540



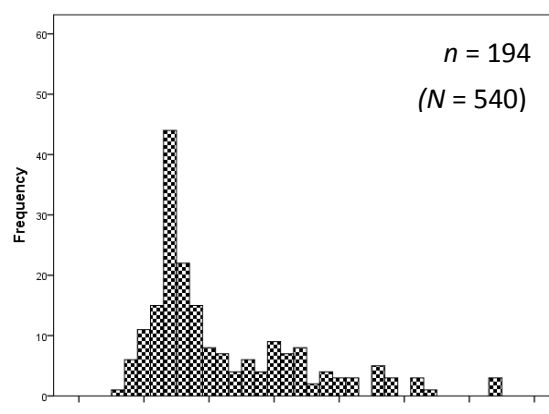
C: Urban Serial Female Offenders:
N = 540



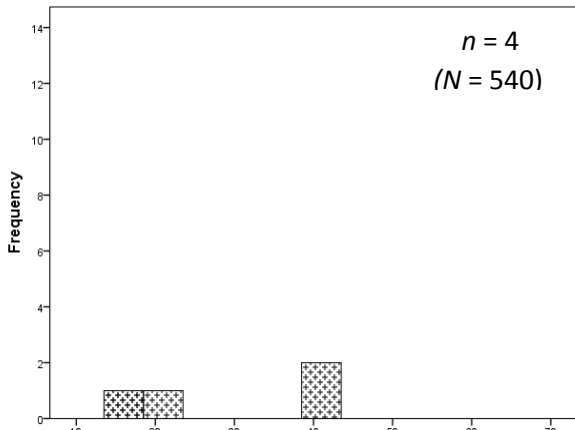
D: Urban Serial Male Offenders:
N = 540



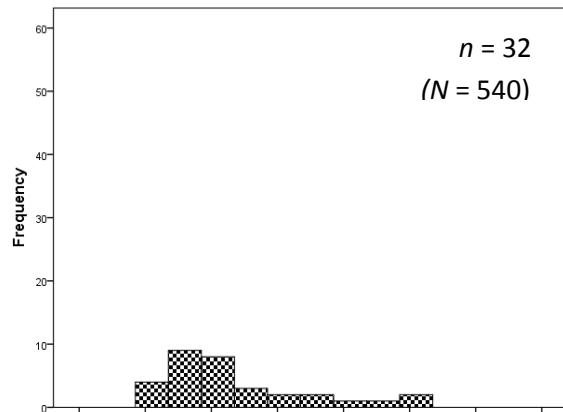
E: Rural Single Female Offenders:
N = 540



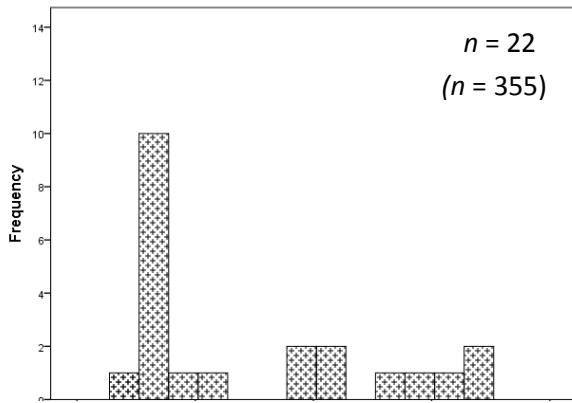
F: Rural Single Male Offenders:
N = 540



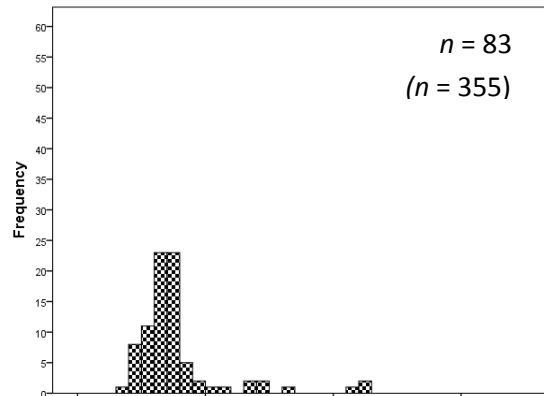
G: Rural Serial Female Offenders:
N = 540



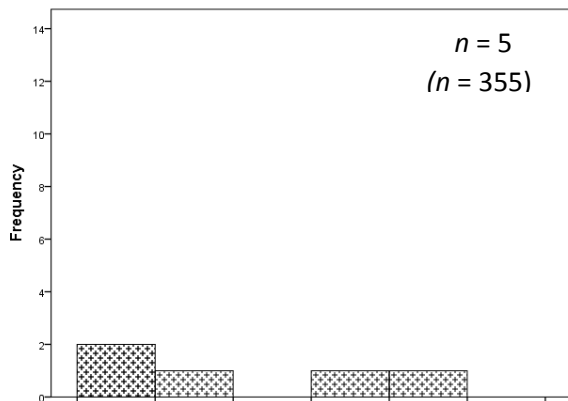
H: Rural Serial Male Offenders:
N = 540



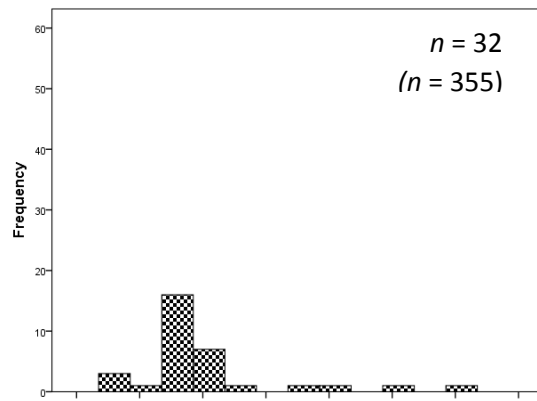
I: Urban Single Female Offenders:
n = 355



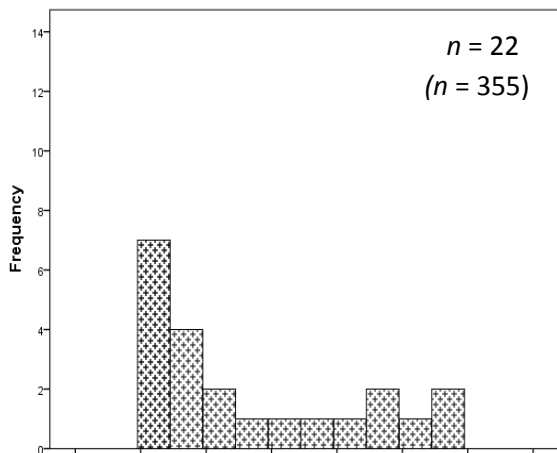
J: Urban Single Male Offenders:
n = 355



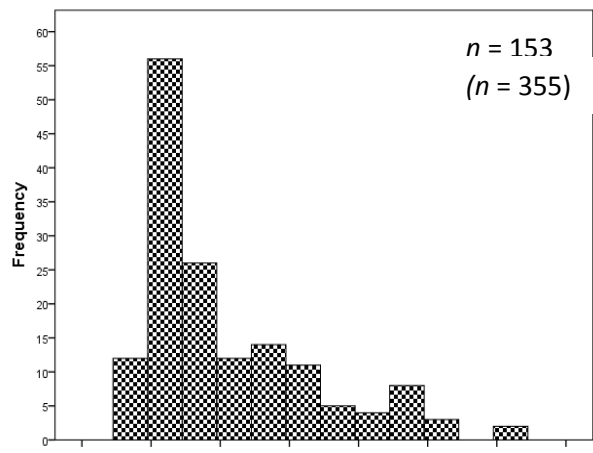
K: Urban Serial Female Offenders:
n = 355



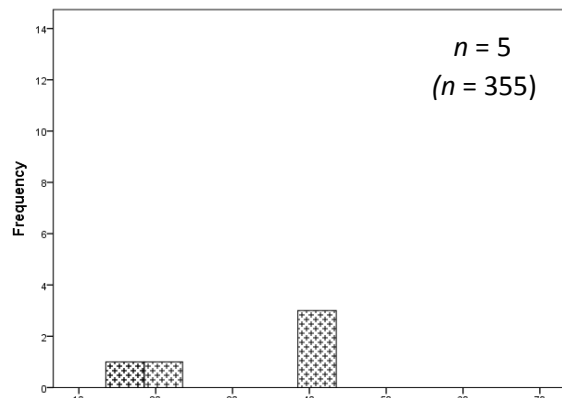
L: Urban Serial Male Offenders:
n = 355



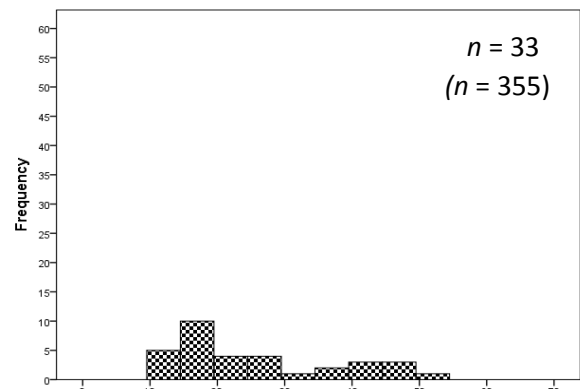
M: Rural Single Female Offenders:
n = 355



N: Rural Single Male Offenders:
n = 355



O: Rural Serial Female Offenders:
n = 355



P: Rural Serial Male Offenders:
n = 355

APPENDIX 5

Offence Related Behaviour Coding Dictionary		
Variable	Coding	Total <i>N</i>
Residential	A target was coded as a residential property ($n = 107$) if the property at the time of the fire was being used for residential purposes (one family house, villa, bungalow, flat etc.), and not a residential property ($n = 248$) if that was not the case.	355
Business	A target was coded as a business ($n = 37$) if the location was currently in use as business premises, irrespective of location or size property at the time of the fire was being used for, and not a business ($n = 318$) if that was not the case.	355
School	A target was coded as a school property ($n = 62$) if the property at the time of the fire was being used as an educational establishment, and not a school ($n = 293$) if that was not the case.	355
Public Building	A target was coded as a public building ($n = 54$) if it was a building to which the public have access; such as, library, church, town hall, law courts, police station, hospital, etc. Schools were not included in this category. The target was not coded as a public building ($n = 301$) if this was not the case.	355
Vehicle	A target was coded as a vehicle ($n = 60$) if it was a means of transportation, including cars, motorbikes, bicycles and boats, and not a vehicle ($n = 295$) if that was not the case.	355
Miscellaneous	A target was coded as a miscellaneous ($n = 82$) if the item was not inside a building property or on the grounds of building property ground, for example, a rubbish bin or park bench, and not miscellaneous ($n = 273$) if that was not the case.	355
Self	A target was coded as self ($n = 22$) if an individual set a fire to their own home, and made no attempt to leave the property, and not self ($n = 333$) if that was not the	355

	case.	
Own Home	A target was coded as own home ($n = 59$) if the offender set fire to their own home but then left; i.e. the purpose was not to endanger their own life, and not own home ($n = 296$) if that was not the case.	355
Multiple Sites	Offences were coded with multiple fire sites ($n = 75$) if they set fire on the floors of two or three different rooms, and not own home ($n = 296$) if that was not the case.	355
Multiple Items	Offences were coded multiple items ($n = 44$) if the offenders set light to multiple specific objects, such as a chair and a sofa, or some bins, which may or may not be in the same site, and not multiple items ($n = 311$) if that was not the case.	355
Solo/Group Offending	Offenders were coded as solo offenders ($n = 156$) if all of their arson records indicated that they had acted alone and group offenders ($n = 199$) if they at any point had offended with others.	355
Planned	An offence was coded as planned ($n = 144$) if materials were used which required thinking ahead, such as acquiring petrol or other fireable fluids as accelerants, and/or making an effort to avoid detection by, for example, wearing gloves when handling petrol containers, and the offence was coded as not planned ($n = 211$) if that was not the case.	355
Accelerant (planned and unplanned)	An offence was coded as accelerant ($n = 164$) if any type of accelerant was used, such as petrol, lighter fuel, propane, wood, cardboard or other items which might speed up the process of the fires, and the offence was coded as no accelerant ($n = 191$) if that was not the case.	355
Material Brought	An offence was coded as material brought ($n = 176$) if any type of readily available material was used, such as cigarettes, candles, cloth, dry branches, cardboard, and wood pallets. Material Brought items would thereby, be considered distinct from items acquired in advance to start and accelerate the fire (such as, petrol, propane etc.). If such material was not brought the offence was	355

	not coded as such ($n = 179$).	
Alert	An offence was coded as alert ($n = 79$) if the offender left the crime scene to alert the fire brigade or any other person after or during the fire, and no alert ($n = 276$) if that was not the case.	355
Remain/Returned	An offence was coded as remained/returned ($n = 109$) if the offender remained at the scene, or returned while the fire was still burning, and not remained/returned ($n = 246$) if that was not the case.	355
Alcohol	Offenders were coded as having alcohol abuse issues ($n = 68$) if on their record it was stated that they had long term problems with alcohol and coded as alcohol used ($n = 109$) if their record stated that they had been under the influence of alcohol just before, during or right after the crime.	355
Travel Distance	Travel distance referred to the distance the offender travelled from their home location to crime scene in km.	540
Travel Distance $0 / < 0$	Offenders were coded 0km ($n = 30$) if they did not travel from home to set fire and coded more than 0km ($n = 325$) if they travelled from home to set fire.	355
Travel Distance $\leq 5 / > 5$	Offenders were coded 5km or more ($n = 110$) if they travelled 5 km or more from home, whereas, offenders were coded less than 5km ($n = 245$) if they did not.	355
Victim Known	Offences were coded as victim known ($n = 176$) if the offender knew the victim in any way. This could be private through relations, such as friends and family, but also people representing institutions or governing bodies that the offender had been involved with, such as a school, social services, counsels, landlord, etc, and victim not known ($n = 179$) if that was not the case.	355
Victim Ex-Partner	Offences were coded as victim ex-partner ($n = 20$) if the property fired belonged to the ex-partner of the victim or someone close to the ex-partner of the victim, such that the deed was clearly aimed at the ex-partner, and victim not ex-partner ($n = 335$) if that was not the case.	355
Prior Violence Towards Victim	Offences were coded as prior violence towards victim ($n = 66$) if there was any prior record of a violent	355

	dispute with the victim, and no prior violence towards victim ($n = 289$) if that was not the case.	
Prior Threats Towards Victim	Offences were coded as prior threats towards victim ($n = 42$) if there were any records of prior verbal or physical threats towards the victim, and no prior threats towards victim ($n = 313$) if that was not the case.	355
Lives Endangered Deliberately	Offences were coded as lives endangered deliberately ($n = 124$) if it appeared clear that the fire was aimed to deliberately harm someone, and no lives endangered deliberately ($n = 231$) if that was not the case.	355

Appendix 6:

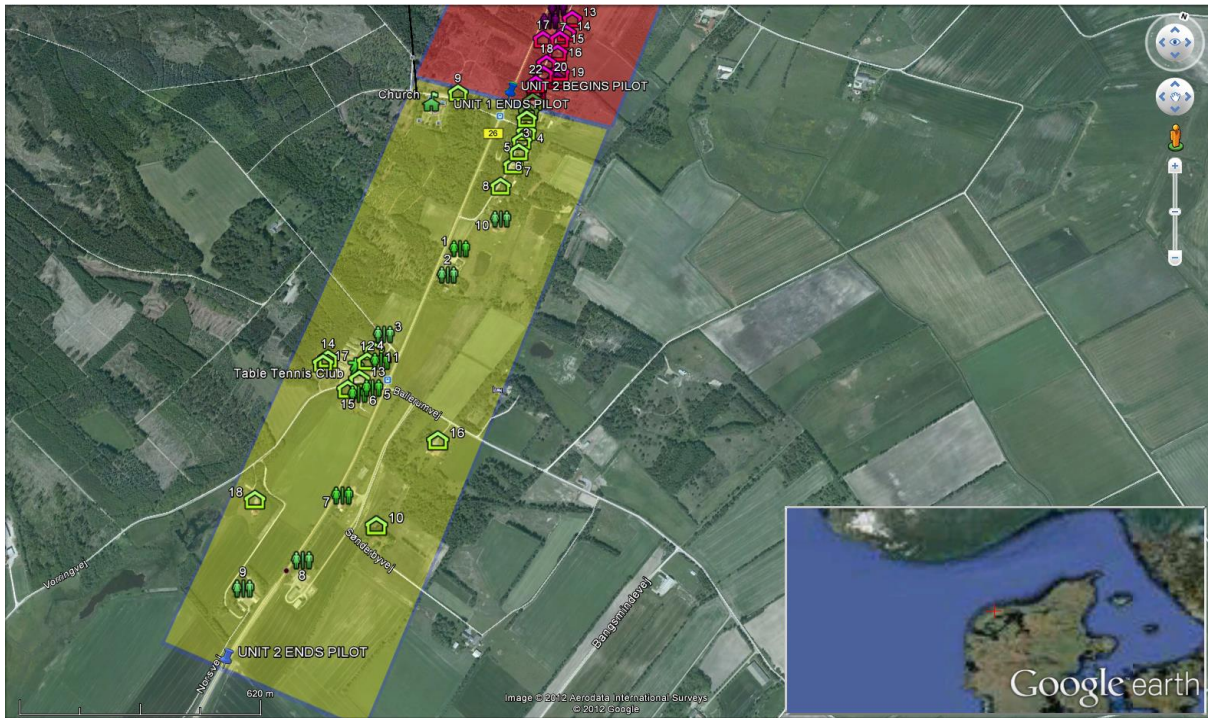
Zero Order Associations between Offence Related Behaviours.

Table Appendix 2 Associations between Offence Related Behaviours, (Second row p values; n = 355; .000 indicates p < .0001.)

	Busin	Scho	PubB	Vehic	Misc	Self	Home	Know	Expa	Viol	Threa	Lives	Items	Plann	Solo	Sites	Accel	MatBr	Alert	Rema	Alcoh	Trav
Target Residenti	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.006	.000	.253	.573	.000	.000	.305	.000	.001	.000	.000	.402
Target Business	-.157	-.119	-.154	-.099	-.088	-.152	-.104	-.043	-.021	-.039	-.037	-.100	.000	-.032	-.041	.017	-.062	.017	-.067	.044	.037	.048
Target School	.094	.092	.090	.065	-.118	-.205	.055	-.112	-.144	.107	-.181	.232	-.063	.183	.144	.095	.226	-.050	-.242	-.187	-.052	.331
Target PublicBldg			.123	-.195	-.076	-.147	-.113	-.103	-.102	.112	-.064	.293	-.014	.217	.184	.127	.192	-.189	-.095	-.222	.038	.477
Target Vehicle					-.247	-.116	-.201	-.274	-.078	-.061	.091	-.283	.173	-.020	.157	.135	.261	.139	-.187	-.219	.127	.114
Target Miscellan						.008	.010	.004	.153	.000	.372	.000	.026	.109	.042	.001	.001	.179	.000	.387	.003	.008
Target Self						.544	.255	.039	.177	-.058	.326	-.061	-.093	-.290	.096	-.191	-.232	-.025	.386	.025	-.034	.522
Target Home							.397	.121	.215	-.117	.451	-.030	-.014	-.352	.121	-.095	-.201	.107	.441	.069	-.032	.545
Victim Known								.242	.445	-.021	.360	-.191	.291	-.220	-.039	.229	.093	.056	.208	.206	.022	.685
Victim Expartner									.448	-.090	.154	-.055	.022	-.227	-.007	-.006	-.096	.046	.076	.226	.008	.876
Prior Violence										-.085	.379	-.092	.195	-.350	-.070	.080	-.025	.005	.216	.202	.110	.038
Threat to Victim										.108	.000	.084	.000	.000	.189	.132	.640	.919	.000	.000	.038	.047
Lives Endanger											-.159	.047	.088	.272	-.019	.115	.195	.014	-.093	-.007	.373	.059
Multiple Items												.003	.372	.097	.000	.726	.030	.000	.797	.082	.897	.268
Arson Planned															.141	.603	.000	.104	.000	.708	.000	.066
Solo/Grp																						.268
Multiple Fire Sites																						.066
Accelerant Used																						.066
Material Brought																						.066
Alert Given																						.066
Remain/Return																						.066
Alcohol Use																						.066

Appendix 7

Example of Google Earth Street View outputs



A unit has been marked with starting point and end point, as well as an image overlay to show the exact area the unit contains. This unit is from a rural area and contains 10 assessed properties and 18 non-assessed properties.

APPENDIX 8

Environmental Coding Dictionary for Property Variables		
Variable	Coding	Total <i>N</i>
Graffiti	The individual properties were coded as some level (1.0 or 0.5) of graffiti ($n = 37$) when there was found writing or drawings scribbled, scratched, or sprayed on a wall of a private property. On some buildings graffiti was allowed and hence was not given a score. For example, on day care institutions for children, graffiti is often used on the wall to decorate the building. A score of 0.00 were given to the individual property if no graffiti were found ($n = 200$). Of the 294 units it was not possible to score 57 units for graffiti.	294
Maintenance Property	The individual properties were coded as some level (1.0 or 0.5) of lack of maintenance ($n = 216$) if the condition or the state of the property indicated clear indications that the building was not cared for: for example, damaged brickwork, rotting woodwork, paint peeling off the walls, moss on roof tiles, garden tools, boxes, and toys spread over the ground. A score of 0.00 were given to the individual property if they were well taken care of ($n = 21$). Of the 294 units it was not possible to score 57 units for maintenance.	294
Fences and Hedges	The individual properties were coded as having some level (0.0 or 0.5) of fences or hedges ($n = 232$) if any barrier, railing, or other upright structure (typically wood, wire, bushes or hedges), including symbolic barriers such as rows of stones or flowers, enclosed or demarked the private area. A score of 1.0 was given if no such barrier or border was present ($n = 7$). Of the 294 units it was not possible to score 57 units for fences and hedges.	294
Territorial Markers	The individual properties were coded as with some level (0.0 or 0.5) of territorial markers ($n = 202$) if the property stands out as belonging to, or have significance for, certain individuals, such as personalised signs, benches, indications of a dog guarding the property and unique or special items, such as statues, or personalised plant displays. A score of 1.0 was given if no such territorial markers were present ($n = 35$). Of the 294 units it was not possible to score 57 units on territorial markers.	294
Surveillance from property	The individual properties were coded as with some level (0.0 or 0.5) of surveillance ($n = 236$) in terms of how well the owners were able to overview the property from inside the building. Trees, walls and bushes hindering the view would result in a lower score as they potentially offer a place to hide from open view. A score of 1.0 was given to a property which offered no surveillance from inside the property ($n = 1$). Of the 294 units it was not possible to score 57 units on	294

	surveillance.	
Surveillance of Entry	The individual properties were coded as with some level (0.0 or 0.5) of surveillance of entry in terms of how well the main entrance could be seen from the street or neighbours ($n = 225$). A score of 1.0 was given to a property where the main entrance was completely hidden or could only be spotted for a short moment by a passer-by ($n = 12$). Of the 294 units it was not possible to score 57 units on surveillance of entry.	294
Parking	The individual properties were coded as with some level (0.0 or 0.5) of surveillance from parking ($n = 233$) if the car was parked in an open forecourt, for example, sends a signal to a possible intruder that at any time there could be someone entering the car with full surveillance, giving the intruders little time to flee before spotted. Thus, a score of 1.0 was given, for example, to a property where the car was parked in a closed garage, parked behind the building, or where there was no sign of a car ($n = 4$). Of the 294 units it was not possible to score 57 units on parking.	294
Percentage of assessed properties	Due to lack of accessibility on Google Earth Street View, not all properties within a unit could be scored, and in some units no individual properties could be scored; this meant that in some units measurements are more likely to be reliable than in others. As a control, therefore, the percentage of assessed properties per unit was also included as a predictor in the regression analyses.	294

APPENDIX 9

Environmental Coding Dictionary for Unit Variables		
Variable	Coding	Total <i>N</i>
Urban/Rural	A unit was scored 1.0 if situated in an urban ($n = 108$) area and 0.0 if it was a unit situated in the rural ($n = 186$) area. An urban area was defined as such if the population density was above 100 inhabitants per square kilometre and the unit had the characteristics of a town or city area, such as higher building density, public transportation hubs, dense network of roads, electrical power grids and characterized by an urban infrastructure in general.	294
Territorial Markers	At the unit level, each unit was given a score of 0.0 ($n = 79$) if there were any territorial markers in the unit, and a score of 1.0 ($n = 215$) if there were no territorial markers in the unit. Territorial markers were defined as those items which made the unit stand out as belonging to, or have significance for, certain individuals. For example, they could be personalised signs in front of houses or communal areas, benches in front of properties or communal areas put there for use by owners, and unique or special items on properties and communal areas, such as statues, personalised plant displays or other elements not common to all properties or areas.	294
Maintenance Unit	A unit was given the score of 0.0 ($n = 190$) if the unit was generally well maintained and a score of 1.0 ($n = 104$) if it was not well maintained. A unit was scored as well maintained if it gave an overall impression of being in a good state of repair and generally well looked after; for example, clean bus stops, clearly defined road surface markings, intact night lighting, etc. If an area was in disarray because of building works (trucks, cranes, cement mixer etc. present) it was scored as 0.0, on the assumption that that maintenance was undergoing.	294
Litter	A unit was given a score of 1.0 ($n = 108$) if there were signs of any litter in the unit and a score of 0.0 ($n = 186$) if there was no litter in the unit. Litter was defined as rubbish such as paper, cans, and bottles left lying in an open, or public, place.	294
Industry Proximity	A unit was given the score of 1.0 ($n = 189$) if the nearest industrial area was within one km of the edge of the unit, and a score of 0.0 ($n = 105$) if the nearest industrial area was one or more kilometres away. An industrial area was defined as any area allocated for industry; for example, light industry, service industry, general industry, hazardous, noxious or offensive industry, waterfront industry, and extractive industry.	294
High Rise Buildings	A unit was given the score of 1.0 ($n = 120$) if there were one or more high rise buildings present in the unit, and a score of	294

	0.0 ($n = 174$) if there were no high rise buildings in the unit. A high rise building was defined as a building of at least two stories, with a separate entrance door for each story but one main entrance door, designed for more than one family.	
Terrace Houses	A unit was scored as 1.0 ($n = 83$) if there were one or more terrace houses in the unit and a 0.0 ($n = 211$) if there were no terrace houses in the unit. A terrace house was defined as a house built as part of a continuous row in a uniform or partly individual style, connected wall to wall and no more than two stories high.	294
Public Buildings	A unit was scored as 1.0 ($n = 126$) if there were one or more public buildings in the unit and a 0.0 ($n = 168$) if there were no public buildings. Public buildings were defined as a buildings used by the public for any purpose, such as assembly, education, entertainment, or worship. Examples include, churches, municipal buildings, shelters for homeless people, train and bus stations, and libraries.	294
Commercial Buildings	A unit was scored as 1.0 ($n = 145$) if there were one or more commercial buildings in the unit and a 0.0 ($n = 149$) if there were no commercial buildings found. A commercial building was defined as a property from where merchandise is sold and usually marked by signs, or a shop name, etc.; for example, kiosks, gas stations, and market places.	294
Entertainment	A unit was scored 1.0 ($n = 44$) if there were one or more buildings associated with entertainment in the unit, and 0.0 ($n = 150$) if there were no entertainment buildings. An entertainment building was defined as one intended to provide people with amusement or enjoyment; for example, restaurants, theatres, cinemas, bars and pubs, etc.	294
Vacant Buildings	A unit was scored as 1.0 if there were one or more vacant buildings in the unit and a 0.0 if there were no vacant buildings in the unit. A property was defined as vacant if the building appeared abandoned and unoccupied.	294
Distance from Police Station	Distance to the nearest police station was measured, in kilometres, from the edge of the unit closest to the nearest police station, to this police station; this was a continuous variable.	294
Building Density	Building density was calculated as the number of square kilometres in the unit divided by the number of buildings in the unit. It was, therefore, also a continuous variable.	294
Population density	Population density for each unit was another continuous variable calculated in terms of the number of inhabitants in the local area divided by kilometres ² . This was achieved using the relevant 2017 online statistics for the closest population cluster to the relevant unit.	294