The Foraging Perspective in Criminology: A Critical Review of Research Literature

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Abstract

In order to explain how crimes are carried out, and why at a particular place and time, against a specific target, crime researchers increasingly engage with theory and research from behavioural ecology, in particular Optimal Foraging Theory (OFT). However, despite a rise in the number of studies, no overview of their main findings exists. Given the growing focus on OFT as a structuring behavioural framework for crime research, this article attempts to critically review the empirical criminal foraging literature to date. Google Scholar and Web of Science yielded 37 studies, which were grouped into five categories according to the focal decision being modelled. Empirical results largely support predictions made by OFT. There remains much potential for future crime research, however, in particular regarding the theoretical foundation of OFT in criminology and through the application of contemporary extensions to OFT using specific tools developed for the study of animal foraging decisions.

Keywords: Offender-forager, Environmental criminology, Behavioural Ecology, Critical Review, Optimal Foraging Theory

INTRODUCTION

As a branch of criminology, environmental criminology concerns itself with explaining where and when crimes occur. In an effort to formally explain why crime is unevenly and non-randomly distributed in time and space (Brantingham and Brantingham, 1993), researchers make use of the Rational Choice Perspective (RCP) and the associated crime opportunity theories (Cornish and Clarke, 1986; Cohen and Felson, 1979). Within RCP, criminal behaviour is framed as purposive behaviour, in the sense that people act in order to attain valued goals. Each subsequent action is selected from a range of (legal and non-legal) alternatives, based on an evaluation of the costs and benefits associated with a particular behavioural alternative. RCP is abstract however, and “requires supplementary empirical content through specification of the relevant aims and choice situations” (Bernasco, 2009: 6). Crime researchers therefore increasingly supplement RCP with theoretical insights from behavioural ecology, a branch of biology that studies the ecological and evolutionary basis of the behavioural patterns of organisms with a focus on how an organism’s behaviour affects its fitness, in particular with Optimal Foraging Theory (OFT, see Brantingham, 2013; Johnson, 2014; Johnson et al., 2009b).

OFT is a behavioural ecology framework that studies how organisms’ behavioural patterns of seeking, selecting and processing resources necessary for survival are the result of evolutionary and ecological forces (Stephens and Krebs, 1986a). OFT contains a wide range of specific hypotheses, research methods, and tools of analysis that have been developed over the years (Stephens et al., 2007; Stephens and Krebs, 1986a), with many a priori predictions bearing close similarity to criminal decision-making (Bernasco, 2009; Felson, 2006a; Johnson and Summers, 2015; Johnson, 2014). A growing number of studies have adopted a foraging perspective when exploring criminal activities, including studies regarding car theft (Brantingham, 2013), residential burglary (Johnson et al., 2009b; Townsley et al., 2016), and maritime piracy (Marchione and Johnson, 2013).

However, despite a rise in the number of studies, no overview of their main theoretical underpinnings and findings exists. Given the growing focus on OFT as a structuring framework for crime research, this article critically reviews the published criminal foraging literature to date. In doing so, we identify knowledge gaps, methodological limitations and opportunities for future research. This article is structured as follows. First, OFT is discussed and framed within the criminological literature. Second, we present the inclusion criteria for the sampled studies and the search strategy employed to find relevant literature. Third, the sampled studies’ main objectives and findings are critically assessed and
synthesized. Finally, we conclude this paper with a discussion of the findings and the implications for future research and criminological theory in general.

OPTIMAL FORAGING THEORY

Optimal Foraging Theory (OFT) is a framework within behavioural ecology that studies the behaviour of animals when searching for food, while accounting for the costs and risks associated with their foraging behaviour (Stephens and Krebs, 1986b; Davies et al., 2012). All animals must eat in order to sustain themselves, but they differ in what food they choose to eat, as well as how they search for, acquire and process food. OFT addresses this and assumes that ecological and individual constraints, in addition to evolutionary stress, pressures animals to optimize their foraging activities over extended periods of time. OFT can be summarized as a wide range of formal models and a priori hypotheses with regard to what animals forage (Charnov, 1976b; Sih and Christensen, 2001), where animals forage (Nonacs, 2019), when animals forage and for how long (Charnov, 1976a; Marshall et al., 2013), how animals forage in group (Waite and Field, 2007; Giraldeau and Pyke, 2019), and how animals move while foraging (Pyke, 2019). Extensions of the classic models account for complications in foraging such as competition for and specialization in resources (Baird, 1991; Funk, 2019) as well as the emergence of suboptimal behavioural strategies and the adoption of apparent irrational decision-making (Smith et al., 2016; Vasconcelos et al., 2015). Taken together, OFT offers a broad suite of formal behavioural rules and hypotheses to address purposeful behaviour.

The assumption of optimization is useful, since it allows to rely on the logic of optimality modelling as an investigative technique to predict how animals should behave (Parker and Smith, 1990). Like all optimality models, models developed under OFT are comprised of three components (Stephens and Krebs, 1986a: 5-11):

- **Decision** components: a problem or choice that is to be evaluated;

- **Currency** components: how the actors’ decisions are to be evaluated. This further breaks down into a currency principle that captures the actual outcome of the foraging problems and requires a priori specification of costs and benefits that are pertinent to a foraging problems, and a choice principle that details how decisions are valued; and

- **Constraints** components: defining the limits on the available choice options and payoffs.

There have been attempts to utilize OFT in the study of contemporary human behaviour, such as the way humans process digital information (Pirolli and Card, 1999), or as a model for consumer behaviour (Rajala and Hantula, 2000). The introduction of the metaphor that likens offenders’ behaviour to those of foraging animals goes back to a number of works in criminology. As far as the authors are aware, Fagan and Freeman (1999) were the first to refer to foraging in a criminological context by comparing the switching between legal and illegal income-generating activities with the foraging decisions animals face. In addition, Johnson and Bowers (2004b) compared burglars’ subsequent target choices with foraging strategies, while Felson (2006a) noted the general similarities between aspects of criminal decision-making and questions addressed in animal ecology. Bernasco (2009) specifically illustrates how OFT can aid researchers to think about the way crimes are carried out, outlining several established foraging models and how they can be applied to crimes against property. Several foraging models have been developed through the years, offering explanations regarding animals’ diet choices (Charnov, 1976b), their choice of foraging territory (Pyke, 1984), and how long to continue foraging in a particular territory before moving on (Charnov, 1976a), among others. As will be illustrated in this review, only a handful of these models have been applied directly in environmental criminological research so far.
METHOD
The existing literature is synthesized by undertaking a critical review. Studies are eligible for inclusion if they meet the following criteria:

a. Theory: studies need to explicitly mention *(Optimal) Foraging Theory* as their underpinning framework.

b. Subject: studies should focus on *environmental criminological themes*, either focusing on crime or crime control.

c. Study design: only *empirical* studies are included, with no distinction in terms of the methodology used.

To identify relevant studies, we searched Google Scholar (GS) and Web of Science (WoS). This of course limits the sample to studies published in these databases. We selected GS because this database consistently returns a higher number of publications compared to traditional scientific databases, especially for the social sciences (Martín-Martín et al., 2018). However, the lack of quality control and clear indexing guidelines suggest it should be used in combination with controlled databases such as WoS (Halevi et al., 2017). While GS also includes PhD theses and working papers, these were excluded for this review. For WoS, searches were conducted on June 11th 2019 using the following key words: *forag* AND (*crim* OR *delinq* OR *offen*). A total of 189 hits were obtained this way. Since the use of Boolean operators is somewhat inconsistent for GS (Halevi et al., 2017), several separate search tasks were completed in this database using combinations of the following key words: *forager/foraging/forage*; *crime/criminal*; *delinquent/delinquency*; *offender/offending/offense*. GS was consulted on June 12th 2019. Each combination resulted in an extraordinary amount of hits. This is partly due to the fact that GS automatically searches for matching and similar meaning words. However, the relevance of retrieved studies quickly dropped after the first hundred studies. For each combination of key words, only the first 250 studies were evaluated (as ranked by GS), which should ensure that the majority of relevant studies are included. In order to increase useful hits, GS’ *cited by* feature was employed to find studies that referred to studies that matched the researchers criteria. To see whether studies matched the criteria for inclusion in this review, they were evaluated based on title, abstract and contents (in that order). Both databases combined yielded 37 studies that matched all of the criteria outlined above.

RESULTS
The findings are presented according to the focal decision being modelled. For each category, the theoretical model is explained, followed by a discussion of the sampled studies’ aims, data and methods, and a summary of their main findings. All included studies are summarized in table 1.

[Spatial target selection](#)
Eight of the included studies used OFT to explain how offenders choose where to offend, ranging from larger areas to individual households. Similar to a rational actor, an optimal forager prefers targets that maximize gains, while minimizing effort and risk. By extension, areas seeming to contain valuable items that are in close proximity and are relatively easy to acquire will be more attractive. It follows that if offenders are assumed to behave like optimal foragers, they will attempt to maximize their revenues by selecting areas that are relatively easy to navigate to, seem affluent and appear to be low in surveillance so that the risk of apprehension is small.

[INSERT TABLE 1 AROUND HERE]
Six studies relied on recorded crime data by law enforcement agencies or municipal administration (Bernasco and Nieuwbeerta, 2005; Bernasco, 2006; Malleson et al., 2012; Malleson et al., 2013; Medel et al., 2015; Bernasco, 2010). Pires and Clarke (2011) relied on secondary data on bird species sold at an illegal pet market, while Malleson (2012) used no real life crime data. In order to account for individual offender characteristics, a number of studies used data on cleared offenses (Bernasco and Nieuwbeerta, 2005; Bernasco, 2006; Bernasco, 2010) or included attributes of suspects and witnesses as a proxy for offender characteristics (Malleson et al., 2012). Most studies focused on residential burglary (Bernasco and Nieuwbeerta, 2005; Bernasco, 2006; Bernasco, 2010; Malleson et al., 2012; Malleson, 2012; Malleson et al., 2013), while the study performed by Medel et al. (2015) deals with drug smuggling. Finally, one study investigates illegal wildlife trade, specifically focusing on parrot poaching (Pires and Clarke, 2011).

This section is characterised by four different analytical approaches. The first approach applies the discrete spatial choice framework to burglars’ location choices (Bernasco and Nieuwbeerta, 2005; Bernasco, 2006; Bernasco, 2010), while a second approach opted for Agent-Based Models (ABM) to simulate burglars’ decision-making (Malleson et al., 2012; Malleson, 2012; Malleson et al., 2013). Third, Medel et al. (2015) used a network analytical approach to drug smuggling routes. Finally, Pires and Clarke (2011) correlated the number of parrots for each species found at an illegal pet market with a number of attributes expected to impact their desirability.

Results of studies that focused on testing components of OFT seem to be largely in line with its predictions. Burglars prefer areas that are affluent and contain many dwellings (Bernasco and Nieuwbeerta, 2005; Bernasco, 2010), appear low in surveillance (Bernasco and Nieuwbeerta, 2005), are physically accessible (Bernasco and Nieuwbeerta, 2005; Bernasco, 2006), and are in close proximity to offenders’ homes (Bernasco, 2006; Bernasco, 2010). Malleson et al. (2012) found that real residential burglary patterns show similarity to simulated patterns based on optimal foraging agents, while Medel et al. (2015) demonstrated that drug smuggling routes are selected to maximize profits and minimize costs and risks. Finally, it seems that parrot species that occur more often at illegal pet markets is likely the result of their overall abundance, accessibility to humans and overall enjoyability as pets, indicating that parrot poachers might be acting as optimal foragers (Pires and Clarke, 2011).

**Spatio-temporal clustering of crime and crime-control**

By far the largest amount of criminal foraging research is dedicated to spatio-temporal crime patterns and the issue of repeat and near-repeat offending (N = 24). This phenomenon is characterized by an increased risk of victimization after prior victimization at or near a particular location (Johnson et al., 2009b). Research has shown that following a successful burglary for example, the risk of burglary is temporally elevated for the same or nearby households, which decays over time (Johnson and Bowers, 2004a; Johnson and Bowers, 2004b). This leads to the observation that criminal events not only cluster in space, but also in time. This is similar to questions about how long animals forage in a particular environment before leaving a particular location in search of better opportunities. The patch departure model or marginal value theorem (Charnov, 1976a) has been the subject of extensive study in behavioural ecology (Watanabe et al., 2014; Zach and Falls, 1976; Krebs et al., 1974), and can be regarded as the “most successful empirical model in behavioural ecology” (Ydenberg et al., 2007: 12). This model describes the behaviour of organisms foraging for food that is unequally distributed in patches in the environment, i.e. food is abundant in some places but not in others. Applied to criminal foraging, this framework is centred around a particular set of assumptions, which are not equally emphasized in all sampled studies.

First, in line with RCP, it is assumed that offender decision making involves weighing benefits, costs and risk, with offenders preferring alternatives that maximize the amount of resources obtained, while
minimizing effort and the risk of apprehension (see also Spatial target selection). Second, targets that are proximate to each other are on average also more similar, reflecting the first law of geography (Tobler, 1970). Third, the foraging perspective applied here places particular emphasis on the fact that offenders learn about their environment after committing the first offense in a particular location (Bernasco et al., 2015; Johnson and Bowers, 2004a; Johnson et al., 2009b; Rey et al., 2012; Rosser et al., 2017; Youstin et al., 2011; Sidebottom, 2012). Combined with the previous assumption, this acquired knowledge reduces uncertainty for the offender about targets in the vicinity of previously targeted resources. This is especially true shortly after the first offense, since circumstances are less likely to have changed by then (Bernasco et al., 2015). This is similar to the sampling behaviour of animals, exploring environments to evaluate whether they are worth the time, risk and effort (Stephens and Krebs, 1986a: 81). Finally, the decay in risk over time is believed to be primarily the result of an increased risk of detection as time goes on, either due to an increase in police attention or citizen vigilance (Hering and Bair, 2014; Johnson and Bowers, 2004a; Johnson and Bowers, 2004b; Johnson et al., 2009b; Rosser et al., 2017; Wheeler, 2012; Youstin et al., 2011). Additionally, as offenders keep foraging in the same area valuable resources become scarcer over time, which prompts offenders to move on to richer areas (Hering and Bair, 2014; Chainey and Silva, 2016; Johnson et al., 2009b). Combined, this leads to the conclusion that optimally foraging offenders will continue offending in the same area after successfully committing a crime, until the perceived costs and risks outweigh the benefits.

While there are many studies that employ OFT as a framework to investigate spatio-temporal patterns in criminal activity, these differ in terms of how central OFT is to the research and which specific hypotheses are being tested. Li et al. (2014) briefly refer to OFT as an explanatory framework for temporally constrained clusters of crime, but do not explicitly test hypotheses from OFT. Yu and Maxfield (2013) state that foraging offenders are a possible mechanism in near-repeat victimization without much clarification. Furthermore, both Bernasco et al. (2015) and Nobles et al. (2016) claim that OFT suggests that offenders should learn from previous offenses. Sorg et al. (2017) explicitly operationalise the three components of optimality modelling (decision, currency and constraints), which no other study does. Direct tests of foraging behaviour either measure the extent of spatio-temporal clustering of crime (Johnson and Bowers, 2004a; Chainey and Silva, 2016; Rey et al., 2012; Townsley and Oliveira, 2015; Chainey et al., 2018; Porter and Reich, 2012), or whether individual offenders tend to return to previously target areas (Bernasco et al., 2015; Porter and Reich, 2012; Hering and Bair, 2014). The distinction between both approaches follows from the type of data available, i.e. whether the data is aggregated or associated with individuals. Not all studies aim to test hypotheses from OFT. More commonly, they use OFT to inform predictive models of crime (Rosser et al., 2017; Johnson et al., 2009a; Gerstner, 2018; Glasner et al., 2018).

The majority of studies rely on recorded crime data by law enforcement agencies or international organisations (Chainey and Silva, 2016; Braithwaite and Johnson, 2015; Johnson et al., 2009a; Johnson and Bowers, 2004a; Johnson and Bowers, 2004b; Rosser et al., 2017; Townsley and Oliveira, 2015; Youstin et al., 2011; Li et al., 2014; Nobles et al., 2016; Wang and Liu, 2017; Chainey et al., 2018; Gerstner, 2018; Rey et al., 2012; Glasner et al., 2018; Yu and Maxfield, 2013). In a number of studies data on cleared offenses were used (Wheeler, 2012; Bernasco et al., 2015; Hering and Bair, 2014; Johnson et al., 2009b; Porter and Reich, 2012), which allowed the researchers to link crime events to individual offenders. One study conducted a self-report survey on victimization, which was partly due to crime data not being publicly available for the study area of interest (Sidebottom, 2012). Pitcher and Johnson (2011) used agent-based simulations and qualitatively compared the results to those found in previous studies. Finally, in order to test whether police behaviour fits foraging patterns, Sorg et al. (2017) employed data on the number of police-initiated activities undertaken.
Studies in this category predominantly focus on acquisitive crime types, such as maritime piracy (Townsley and Oliveira, 2015), or a combination of crime types such as Youstin et al. (2011) who employed data on shootings, robbery and auto theft, while Hering and Bair (2014) include non-acquisitive crime (in this case, arson) in combination with acquisitive crime types (i.e., robbery, residential, vehicular and commercial burglary). However, the bulk of these studies direct their attention to (residential) burglary either exclusively (Bernasco et al., 2015; Chainey and Silva, 2016; Johnson and Bowers, 2004a; Johnson and Bowers, 2004b; Johnson et al., 2009a; Li et al., 2014; Rey et al., 2012; Rosser et al., 2017; Sidebottom, 2012; Pitcher and Johnson, 2011; Chaine et al., 2018; Glasner et al., 2018; Gerstner, 2018; Yu and Maxfield, 2013; Nobles et al., 2016) or in combination with other crime types (Porter and Reich, 2012; Wheeler, 2012; Johnson et al., 2009b; Hering and Bair, 2014). The study of Braithwaite and Johnson (2015) stands out because of its focus on terrorist insurgency.

Of the studies we identified, only one directly focuses on aspects of crime control instead of criminal activity. In their study Sorg et al. (2017) evaluate police behaviour during hot spot patrols. Hot spot policing is the result of the well validated observation that crime is concentrated in a small number of geographic units (Weisburd, 2015). Police efforts should thus concentrate on those high-crime areas in order to increase the likelihood of reducing aggregate crime levels. However, research suggests that the deterrent effect of police deployment decays as time moves on (e.g., Sherman, 1990). The authors examine the potential influence of changes in police effort on deterrence decay. Officers might leave their assigned hot spots to patrol in other areas as time moves on, a mechanism they term dosage diffusion (see also Ratcliffe and Sorg, 2017). Their results suggest that the amount of time spent outside assigned areas increases as time goes on. Additionally, they found that this process is hastened in areas that are faced with relatively little crime, or in areas that are adjacent to high-crime areas, a result that is in line with the qualitative predictions of OFT’s patch departure model (Charnov, 1976a).

The findings of the sampled studies focusing on testing predictions from OFT applied to offender behaviour mostly suggest that crime does tend to cluster in time and space (Johnson and Bowers, 2004a; Chaine and Silva, 2016; Porter and Reich, 2012; Rey et al., 2012; Townsley and Oliveira, 2015), and that this observation is most likely the result of offenders deploying optimal foraging strategies (Bernal et al., 2015; Johnson and Bowers, 2004b), especially at smaller temporal scales. Braithwaite and Johnson (2015) found that both time-invariant risk heterogeneity as well as offenders returning to previously targeted areas are at play, while computational simulations revealed that accounting for foraging strategies resulted in burglary patterns that agree with previous findings (Pitcher and Johnson, 2011). Interestingly, Hering and Bair (2014) found results markedly inconsistent with OFT. They found that offender activity becomes more clustered as time progresses instead of becoming more dispersed.

**Prey selection**

The third category of sampled studies investigates offender target choices. These studies explicitly draw upon the classic prey model outlined by Charnov (1976b), which tries to explain why animals would eat some types of prey while ignoring others (Araújo et al., 2011). Two of the sampled studies refer to the prey choice model, both examining car thieves’ choice to steal different car make models in Los Angeles, USA (Brantingham, 2013) and Lagos, Nigeria (Badiora, 2017).

This model assumes discrete prey types that differ in terms of value, the effort it takes to capture and process them and their overall abundance in the environment. Applied to car theft, each make model can be ranked according to the ratio between its market value and effort it takes to steal. In addition, foragers are supposed to maximize the average gains per unit of time (i.e., they should try to amass as much value as possible relative to effort by being somewhat selective in what types or cars they are willing to steal). When encountered, the highest-ranked make model should always be stolen given the opportunity. Since it is the best possible make model to steal, the time and effort spent can never be lost.
because there is no better alternative to spend it on. In fact, if this make model is abundant enough, there is no reason to pursue any other type. Such opportunities are rare, however, so that a car thief who specializes entirely on this make model will be left with very few occasions to steal. Consequently, optimally foraging car thieves will add inferior car types to their “diet”, until doing so would no longer increase the average gains per unit of time.

The prey model thus predicts that specialization is the norm, and that offenders should only prefer a wider range of prey types when preferred targets become scarce (Bernasco, 2009). This is a combination of pure rational decision-making (select the option that yields the greatest benefits relative to the costs) and the principle of lost opportunity (ignore targets if the probability of encountering higher-value targets is sufficiently high). This also leads to the somewhat unintuitive prediction that the inclusion of a particular type of prey is independent of how abundant it is, instead depending entirely on the abundance of higher-ranked prey.

Instead of these more detailed predictions, both Brantingham (2013) and Badiora (2017) use recorded crime data to test a more conservative null hypothesis that if all make models are ranked evenly (i.e., if there is no preference for one model over another), each car type should be stolen about as frequently as they occur in the environment. This corresponds to a forager who targets indiscriminately. Using correlational methods, both studies found a significant positive relationship between theft and abundance, but also found that some models were targeted more often than expected based on their relative abundance (and vice versa). The study of Brantingham (2013) additionally finds that the higher theft rates of these models are associated with higher expected values, but not with their handling costs (proxied by average break-in times). This was not tested in the study of Badiora (2017). These studies conclude that abundance is likely the primary predictor of car thieves’ target choices, yet is insufficient on its own to explain theft rates. These findings suggest that offenders might have different target preferences.

**Search patterns of serial offenders**

A fourth category is also concerned with spatio-temporal patterns of offending, and at its core draws from the same foraging models to explain why offenders would return to the same location until some tipping point has been reached (see Spatio-temporal clustering of crime and crime control). However, this says little about the patterns of sequential choices made by offenders in general, or how an optimal foraging offender’s search pattern looks. These studies differ in the fact that they are interested in the distances between subsequent criminal events rather than seeing whether criminal events that occur close in space and time are the work of the same offender.

When describing and theorizing animal foraging patterns, scholars in ecology often refer to different types of walks, with studies finding both evidence for Brownian motions, as well as Lévy walks (e.g. Humphries et al., 2010). The former is characterized by a forager moving in a random direction at each step (unbiased), with step lengths being more or less equal. The latter draws its step lengths from a power law distribution of the form \( P[l] = l^{-u} \), with values of \( u \) normally ranging between 1 and 3 (Viswanathan et al., 1999). In the case of Lévy walks, movements will generally resemble Brownian motions, interspersed with sudden scale-free jumps. Brownian motions can be assumed to occur when suitable targets are abundant in the environment while Lévy walks are assumed to be more optimal in sparse environments (Humphries et al., 2010).

Only two of the identified studies empirically examine such foraging walks. Brantingham and Tita (2008) simulated offender movement using agent-based models, drawing distances from the described foraging walks. These simulations revealed that a relatively simple model was able to generate crime patterns that show apparent similarity to empirical crime clusters. Johnson (2014) examines sequential
inter-crime trips of residential burglars in the UK using data on cleared offenses. The empirical distributions of distances between crime events are compared to those generated by Lévy walks, Brownian motions, and those generated by simple central place foraging strategies whereby offenders are constrained by a base location to which they return (such as their home) and subsequent choices are independent from each other. The data suggest that central place foraging strategies are insufficient to explain the observed distance distribution. Additionally, the author suggests that offenders most likely do not unequivocally stick with one of both strategies (either Lévy or Brownian walks).

Offender mobility
Finally, one study examined the mobility of offenders and how this impacts earnings (Morselli and Royer, 2008). In this study, the authors refer to what Felson (2006a) calls strategic foraging, claiming that “offenders will forage in patches somewhat farther away if additional booty makes it worth their while” (pp. 265). This mobility was, in contrast with previous journey-to-crime studies not operationalized as the distance between home and offense, but rather as the perimeter wherein offenders are active (akin to the operational range of foraging animals, see Felson, 2006). This is similar to questions in animal ecology where animals searching for patches containing food should prefer areas that contain many food items relative to the time and effort spent searching for them (MacArthur and Pianka, 1966). Travel distance is a cost, and this cost must be compensated by the expected value of these areas. Data on mobility and earnings were collected through face-to-face interviews with incarcerated offenders, and subsequently analysed through regression modelling. Their findings suggest that increased mobility is compensated by higher reported earnings, but that this relationship is stronger for predatory crime types (e.g. burglary or robbery) than for market crimes (e.g. drug dealing or fencing).

DISCUSSION AND CONCLUSION
The purpose of this article was to provide an overview of the existing empirical research on criminal foraging, explicitly focusing on the underlying theoretical models being applied and the findings generated by these studies. While the field is very diverse, based on the results outlined here it is apparent that the majority of research is focused on the dynamic foraging models that account for diminishing returns as time goes on. Since RCP is inherently static, criminological research interested in patterns across series of offenses is more likely to refer to foraging models instead. Although research into spatio-temporal decision-making does not necessarily refer to OFT (e.g., Townsley et al., 2003), OFT can help to explain why these observed patterns occur. Moreover, most individual-based research clearly focuses on serial crime types, whereby one offender commits multiple offenses. This is a consequence of the observation that OFT is interested in the fitness consequences of behaviour over sequences of decisions. Methodologically, this translates in studies whereby a small number of animals are observed repeatedly (e.g., Tinker et al., 2012; Araújo et al., 2008), which contrasts with criminological studies where often police recorded crime data on a large number of individuals are available, but who are on average observed less frequently (Johnson, 2014). Finally, there is a predominant focus on acquisitive crime, neglecting other, more expressive crime types (but see Braithwaite and Johnson, 2015; Hering and Bair, 2014).

Although the number of criminological studies referring to OFT is growing, there is still much theoretical work necessary to employ behavioural ecological insights in criminology beyond its heuristic value (Felson, 2006b; Bernasco, 2009). This is partly related to the format of scientific journals which does not always allow to devote much space to the theoretical underpinnings of empirical studies. Additionally, a lack of familiarity with contemporary ecological literature by crime researchers might also be an important limiting factor.
Nonetheless, it is important to note some drawbacks to comparing the behaviour of offenders with that of foraging animals. First, for animals, the only alternative to eating is death. Offenders are not obliged to commit crime and usually have both legal and non-legal alternatives to choose from (which can be approached as a foraging problem in its own right, see Fagan and Freeman, 1999). Second, for many animals the search for food is a full-time activity while offending is often more part-time and discretionary (Pires and Clarke, 2011; Bernasco, 2009). However, efficient foraging increases fitness since surplus time and energy can be spent on reproductive behaviour, which entails that foraging does not necessarily have to be a time-consuming activity in order to be studied using OFT. Finally, for animal diet choices the currency is equal for all, often the calorific intake rate over time (Charnov, 1976a; Charnov, 1976b). For offenders, pay-offs might not be equal, especially when non-monetary gains are involved such as status or thrill-seeking (Goodwill, 2014).

Despite these concerns, it cannot be ignored that research into animal behaviour has proven to be essential for advancing our understanding of human behaviour (Hager, 2010). For example, our insight into human individual, social, and reproductive behaviours has dramatically improved due to research into these behaviours in nonhuman primates (Lindegaard et al., 2017; Brosnan, 2013; Burkart et al., 2018; Muller and Wrangham, 2009). A major advantage of applying OFT to environmental criminological questions lies in the fact that criminology lacks a formal theoretical framework that is able to explain how, when, and where behavioural strategies are enacted (Bernasco, 2009). OFT provides such a theoretical background while also explaining why these patterns occur based on ecological and individual factors in addition to evolutionary stress. Moreover, the hypotheses formulated in OFT are directly compatible with hypotheses that have been formulated and tested in criminology before, such as the often observed pattern whereby offenders largely commit offenses close to their home (e.g., Bernasco, 2006) and the phenomenon that crime tends to cluster in time and space (Johnson and Bowers, 2004b). It is also appealing since OFT does not assume that decision-making is perfectly calculated or deliberate (Bernasco and Nieuwebeerta, 2005) or that foragers are even aware of the complex cognitive processes underlying their decision-making (Ydenberg et al., 2007; Kahneman, 2011). Furthermore, behavioural ecology is a theoretically rich and empirically vibrant field whose continuing theoretical, methodological and analytical advances can continue to inspire and enrich crime research. If nothing more, the heuristic value of the wide range of hypotheses that have been formulated through the years have already proven to be productive in generating new research directions for environmental criminologists. The specific attention of OFT to how foraging decisions evolve over time has led to novel insights in spatio-temporal crime patterns (e.g., Johnson et al., 2009b). Finally, from a pragmatic point of view, the metaphor of the foraging criminal provides a highly visual image aiding communication towards law enforcement agencies (Pease, 2014).

A number of steps might be undertaken to further develop OFT as a formal framework in criminology. First, in order to import principles from OFT to crime science it is necessary to elaborate the relation between evolutionary fitness and economic utility. Even though both utility and fitness fulfil similar roles in their respective disciplines (Schulz, 2014), it is not possible to unambiguously equate one with the other (Binmore, 2012). Interestingly, the relation between both concepts is also subject of behavioural ecological inquiry (Westneat and Fox, 2010), in part because the (a posteriori) utility maximization approach allows the modelling of trade-offs between, for example, safety and food intake (Stephens and Krebs, 1986a). Clarifying if, and under which circumstances, principles of fitness maximization can be interpreted as utility maximization will guide researchers’ decision when it is appropriate to apply models rooted in OFT to offender behaviour. Similarly, clarifying the evolutionary basis of rationality helps integrate criminology with other disciplines.
Second, if the strength of OFT lies in the “specification of the relevant aims and choice situations” (Bernasco, 2009: 6), researchers should be more explicit in the choice situations they are aiming to model, which currency foragers are expected to maximize and under which constraints they operate. Of the sampled studies, only one study elaborated on these elements of optimality modelling which are central to OFT (Sorg et al., 2017). In contrast, for some other studies it was not clear why optimal foraging was preferred over rational choice (e.g., Malleson et al., 2012; Malleson et al., 2013). These studies present the optimal foraging criminal as an alternative to the rational offender, though it is not always clear why one was chosen over the other. To illustrate, Malleson et al. (2012: 8) state that “[b]urglars act as ‘optimal foragers’ when they choose target areas because their decision is based on an analysis of potential rewards against risks” (for a similar description, see also Malleson, 2012). Moreover, this approach places considerable emphasis on the process of arriving at a particular decision (i.e., the analysis of rewards against risks), which is but one aspect of the concept of rationality in the field of biology (Kacelnik, 2006).

Third, researchers can make use of the interrelations between foraging models and different stages of offender decision-making. Bernasco (2006) noted the similarities between the choice process of residential burglars and those of foraging animals. Burglars are assumed to follow a spatially structured, sequential, and hierarchical decision process in selecting their targets (Cornish and Clarke, 1986), which corresponds to first selecting an area and a suitable target second (Vandeviver and Bernasco, 2019). This resembles animals’ decision hierarchy (Stephens, 2008), whereby first a patch to forage in is selected, which influences their subsequent prey selection within this patch (Charnov, 1976b) and how long to keep foraging in a particular patch (Charnov, 1976a). The interrelations between subsequent choices have not been evaluated from an optimal foraging perspective in criminology so far, but could help in the development of a comprehensive offender decision-making framework.

Some methodological issues may limit the potential of the application of OFT models to criminological themes. Studies in animal ecology often collect data by directly observing the species’ behaviour in situ (e.g., Tinker et al., 2012). Due to the nature of criminology’s research subject, however, direct observation of the foraging process is severely restricted (van Gelder and Van Daele, 2014). This forces crime researchers to infer offenders’ decisions from aggregated recorded crime data (e.g., Johnson and Bowers, 2004a). However, assuming that aggregate patterns accurately reflect individual patterns would constitute a logical fallacy (Robinson, 1950). In the case of Johnson (2014), this was circumvented by using data on cleared offenses, but this might erroneously misclassify foraging walks since caught offenders likely differ from unknown offenders (Pease, 2014), in addition to the possibility that the exclusion of attempts could bias results towards longer inter-crime distances. Moreover, given the low clearance rates of detected crimes in most Western countries (Vandeviver et al., 2015), the use of data based on cleared offenses limits the generalizability and applicability of research results to crimes committed by unknown offenders.

Triangulating data sources might prove valuable to offset inherent biases of one particular data type, for example by setting up offender-based study designs. To illustrate, interviews with incarcerated offenders revealed that offenders deliberately disperse activity as time goes on in order to decrease the risk of detection or apprehension, an observation that is in line with predictions from OFT (Summers et al., 2010). Additionally, the use of DNA data holds great potential to study spatio-temporal behaviour of individual (unknown) offenders in general (De Moor et al., 2018), and predictions from OFT in particular.

Finally, recent extensions of OFT might prove to be valuable in the development of criminological theory, with some contemporary issues showing great similarity to issues in criminology. Criminological research into offender decision-making increasingly tries to account for between-
offender differences, for example in the study of variation in journeys to crime (Townsley and Sidebottom, 2010; Van Daele, 2010) or in burglary location choice (Townsley et al., 2016; Frith et al., 2017). Similarly, studies in animal ecology are increasingly attentive to diet variation among members of the same species (e.g., Tinker et al., 2012; Bolnick et al., 2003; Cantor et al., 2013). Theoretical and methodological innovations from these studies might provide valuable insights for researchers.

This study suffers from some limitations. Even though objective and systematic selection criteria for the included studies were used, it is nonetheless possible that some bias occurred due to the choice for only two scientific databases. The decision to only include empirical research also resulted in the loss of some interesting theoretical work (e.g., Burgason and Walker, 2013). Keeping these limitations in mind, the divergent focus of the sampled foraging studies, combined with the observation that OFT is still marginal in criminology, leads us to believe that a critical review is adequate to provide a comprehensive overview of the current state of the field.

In conclusion, the introduction of OFT in environmental criminology has generated much novel research, illustrating that behavioural ecology can both inspire criminological research directions and offer a formal framework to improve our understanding of offender decision-making. Research predominantly draws from the temporal models in OFT, either explicitly or implicitly. This stems from a notable difference between OFT and RCP, namely the fact that foraging models account for temporal shifts in resources and risk in the environment and the subsequent impact on foraging decisions. There remains much potential for future research however. Researchers should prioritize solidifying the theoretical foundation of OFT in criminology and exploring anchor points between behavioural ecology, evolutionary theory, and crime science. Additionally, contemporary extensions to OFT and tools developed for the study of animal foraging decisions show great potential for application to criminal foraging problems. By taking advantage of theoretical and methodological advances in foraging literature, a greater understanding of offender decision-making may develop.

REFERENCES


Townsley M and Sidebottom A. (2010) All offenders are equal, but some are more equal than others: variation in journeys to crime between offenders. *Criminology* 48: 897-917.


<table>
<thead>
<tr>
<th>Study</th>
<th>Geographic region</th>
<th>Period of used data</th>
<th>Studied crime types</th>
<th>Analytic strategy</th>
<th>Purpose or model</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Badiora, 2017</td>
<td>Nigeria</td>
<td>2009 - 2013</td>
<td>Motor vehicle theft</td>
<td>Correlational analysis</td>
<td>Prey selection</td>
<td>There is a positive relationship between target abundance and theft rates, yet abundance in itself is insufficient to explain differences in theft rates.</td>
</tr>
<tr>
<td>Bernasco &amp; Nieuwbeerta, 2004</td>
<td>The Netherlands</td>
<td>1996 - 2001</td>
<td>Residential burglary</td>
<td>Discrete choice analysis</td>
<td>Spatial target selection</td>
<td>The likelihood of a neighbourhood being selected for burglary is positively influenced by the neighbourhood’s lack of guardianship, physical accessibility and the number of potential objects in the area.</td>
</tr>
<tr>
<td>Bernasco, 2006</td>
<td>The Netherlands</td>
<td>1996 - 2004</td>
<td>Residential burglary</td>
<td>Discrete choice analysis</td>
<td>Spatial target selection</td>
<td>Both solitary burglars and burglar groups prefer physically accessible areas that are close to the offenders’ homes.</td>
</tr>
<tr>
<td>Bernasco, 2010</td>
<td>The Netherlands</td>
<td>2002 - 2007</td>
<td>Residential burglary</td>
<td>Discrete choice analysis</td>
<td>Spatial target selection</td>
<td>The likelihood of an area being selected for burglary is positively influenced by the number of properties and their average value, the percentage 15–25 years old in the population and the area’s proximity.</td>
</tr>
<tr>
<td>Bernasco, Johnson &amp; Ruiter, 2015</td>
<td>UK</td>
<td>2007 - 2012</td>
<td>Residential burglary</td>
<td>Discrete choice analysis</td>
<td>Repeat and near-repeat victimisation</td>
<td>Burglars were more likely to commit a burglary in previously targeted areas, as well as areas that are nearby, especially if the prior burglary was recent.</td>
</tr>
<tr>
<td>Braithwaite &amp; Johnson, 2015</td>
<td>Iraq</td>
<td>2005</td>
<td>Insurgent violence</td>
<td>Regression analysis</td>
<td>Repeat and near-repeat victimisation</td>
<td>The location of insurgency is mostly the result of time-invariant risk heterogeneity, and, to a lesser extent, prior victimisation.</td>
</tr>
<tr>
<td>Brantingham &amp; Tita, 2008</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Simulational design: Agent-based modelling</td>
<td>Sequential target selection</td>
<td>The shape and extent of simulated crime clusters is influenced by offender movement strategies: short movement distances generate denser clusters that are close to the offenders’ origin point compared to movement routines that occasionally include longer distance moves.</td>
</tr>
</tbody>
</table>

Table 1: Overview of the included studies’ purpose and main characteristics.
<table>
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<tr>
<th>Reference</th>
<th>Country</th>
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<th>Methodology</th>
<th>Victimisation Type</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chainey &amp; Braulio, 2016</td>
<td>Brazil</td>
<td>2012 - 2014</td>
<td>Residential burglary</td>
<td>Near repeat calculation</td>
<td>Repeat and near-repeat victimisation</td>
<td>The risk of victimisation is elevated following a prior burglary, though the levels of repeat and near-repeat victimisation is much lower compared to those found in Western studies.</td>
</tr>
<tr>
<td>Chainey et al., 2018</td>
<td>New Zealand</td>
<td>2013 - 2014</td>
<td>Residential burglary</td>
<td>Near repeat calculation, kernel density estimation for hotspots</td>
<td>Repeat and near-repeat victimisation</td>
<td>There is a demonstrated pattern of (near-)repeat victimisation, though the extent of these patterns varies across the four study regions.</td>
</tr>
<tr>
<td>Gerstner, 2018</td>
<td>Germany</td>
<td>2015-2016</td>
<td>Residential burglary</td>
<td>Predictive crime mapping, regression analysis</td>
<td>Repeat and near-repeat victimisation</td>
<td>Place-based predictive policing strategies have a moderate effect on burglary reduction. The acceptance of predictive policing within the police force varies.</td>
</tr>
<tr>
<td>Glasner et al., 2018</td>
<td>Austria</td>
<td>2013-2016</td>
<td>Residential burglary</td>
<td>Near repeat calculation, predictive crime mapping</td>
<td>Repeat and near-repeat victimisation</td>
<td>The pattern of residential burglary is influenced by repeat and near-repeat victimisation. Out of two proposed predictive methods that identify future burglary locations, a strategy that uses information on sequences of burglaries is more efficient.</td>
</tr>
<tr>
<td>Hering &amp; Bair, 2014</td>
<td>USA</td>
<td>2010-2011</td>
<td>Residential and commercial burglary, arson, robbery, theft from motor vehicle</td>
<td>Spatial and spatio-temporal cluster analysis</td>
<td>Repeat and near-repeat victimisation</td>
<td>Robbers’ activity becomes more clustered as time progresses instead of becoming more dispersed, inconsistent with OFT predictions. Burglary is mostly clustered, though some burglars avoid clustering by spacing their crimes.</td>
</tr>
<tr>
<td>Johnson &amp; Bowers, 2004a</td>
<td>UK</td>
<td>1999-2000</td>
<td>Residential burglary</td>
<td>Knox test</td>
<td>Repeat and near-repeat victimisation</td>
<td>A prior residential burglary elevates the risk of further residential burglaries in the near future and in close proximity to the victimized home.</td>
</tr>
<tr>
<td>Authors</td>
<td>Country</td>
<td>Year Range</td>
<td>Crime Type</td>
<td>Methodology</td>
<td>Analysis</td>
<td>Notes</td>
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<tr>
<td>Johnson &amp; Bowers, 2004b</td>
<td>UK</td>
<td>1999-2000</td>
<td>Residential burglary</td>
<td>Correlational analysis, Knox Test</td>
<td>Repeat and near-repeat victimisation</td>
<td>Clusters of burglary move as time goes on, mainly shifting to locations near the original cluster.</td>
</tr>
<tr>
<td>Johnson, 2014</td>
<td>UK</td>
<td>2007-2012</td>
<td>Residential burglary</td>
<td>Comparison of probability density function with exponential and power law distributions</td>
<td>Sequential target selection</td>
<td>The distribution of sequential inter-event distances is consistent with both Brownian and Lévy walks. Additionally, offenders most likely do not unequivocally stick with one of both strategies.</td>
</tr>
<tr>
<td>Johnson, Bowers, Birks &amp; Pease, 2009</td>
<td>UK</td>
<td>1996-1997</td>
<td>Residential burglary</td>
<td>Predictive crime mapping</td>
<td>Repeat and near-repeat victimisation</td>
<td>An algorithm based on OFT and the literature on (near-)repeat victimisation predicts the future locations of crime at a level that exceeds chance expectation, and also outperforms other hot-spotting methods.</td>
</tr>
<tr>
<td>Johnson, Summers &amp; Pease, 2009</td>
<td>UK</td>
<td>2001-2005</td>
<td>Residential burglary, theft from motor vehicle</td>
<td>Knox test</td>
<td>Repeat and near-repeat victimisation</td>
<td>Both burglary and theft from motor vehicle cluster in time and space. Crimes of the same type occurring closest to each other in space and time are those most likely to be cleared to the same offender(s).</td>
</tr>
<tr>
<td>Li et al., 2014</td>
<td>UK</td>
<td>2005-2008</td>
<td>Residential burglary</td>
<td>Regression analysis</td>
<td>Repeat and near-repeat victimisation</td>
<td>Areas that are hotspots, coldspots, or neither differ in terms of whether crime rates increase, decrease, or remain stable when compared to the overall rate of victimization.</td>
</tr>
<tr>
<td>Malleson, 2012</td>
<td>UK</td>
<td>NA</td>
<td>Residential burglary</td>
<td>Simulational design: Agent-based modelling</td>
<td>Spatial target selection</td>
<td>Urban regeneration schemes might lower the average victimisation rates of an area, but might elevate the risk for individual households.</td>
</tr>
<tr>
<td>Malleson et al., 2012</td>
<td>UK</td>
<td>2001 and 2004</td>
<td>Residential burglary</td>
<td>Simulational design: Agent-based modelling</td>
<td>Spatial target selection</td>
<td>Real crime patterns show similarity to simulated patterns based on optimal foraging agents.</td>
</tr>
<tr>
<td>Reference</td>
<td>Location</td>
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<td>Crime Type</td>
<td>Method</td>
<td>Spatial Analysis</td>
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<tr>
<td>Medel, Lu &amp; Chow, 2015</td>
<td>Mexico</td>
<td>2006-2010</td>
<td>Drug trafficking</td>
<td>Network analysis</td>
<td>Spatial target selection</td>
<td>Drug smuggling routes are selected to maximize profits and minimize costs and risks.</td>
</tr>
<tr>
<td>Morselli, 2008</td>
<td>Canada</td>
<td>NA</td>
<td>predatory (i.e., robbery, burglary, fraud, auto-theft, and theft) and market crimes (i.e., drug dealing, fencing, smuggling, loan sharking, sex peddling, and illegal gambling operations).</td>
<td>Regression analysis</td>
<td>Criminal mobility</td>
<td>Increased mobility is compensated by higher reported earnings. This relationship is stronger for predatory crime types than for market crimes.</td>
</tr>
<tr>
<td>Nobles, Ward &amp; Tyllyer, 2016</td>
<td>USA</td>
<td>2006-2007</td>
<td>Residential burglary</td>
<td>Regression analysis</td>
<td>Repeat and near-repeat victimisation</td>
<td>Repeat and near repeat burglary patterns are conditional on the level and specific dimensions of neighbourhood disorganisation.</td>
</tr>
<tr>
<td>Pires &amp; Clarke, 2011</td>
<td>Bolivia</td>
<td>2004-2005</td>
<td>Illegal wildlife poaching</td>
<td>Correlational analysis</td>
<td>Spatial target selection</td>
<td>The presence of particular parrot species is likely the result of their environmental abundance, accessibility to humans and overall enjoyability as pets, indicating that parrot poachers might be acting as optimal foragers</td>
</tr>
<tr>
<td>Pitcher &amp; Johnson, 2016</td>
<td>NA</td>
<td>NA</td>
<td>Residential burglary</td>
<td>Simulational design: Agent-based modelling</td>
<td>Repeat and near-repeat victimisation</td>
<td>Computational simulations reveal that accounting for foraging strategies results in burglary patterns that qualitatively agree with previous findings.</td>
</tr>
<tr>
<td>Porter &amp; Reich, 2012</td>
<td>USA</td>
<td>1999-2011</td>
<td>General crime measure</td>
<td>Kernel density estimation</td>
<td>Repeat and near-repeat victimisation</td>
<td>Future crime events are more likely to occur close to past events. The effectiveness of predicting future locations in a crime series greatly increases when accounting for</td>
</tr>
<tr>
<td>Study</td>
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<td>Years</td>
<td>Type of Crime</td>
<td>Methodology</td>
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<tr>
<td>Rey et al., 2012</td>
<td>USA</td>
<td>2005-2009</td>
<td>Residential burglary</td>
<td>Conditional Spatial Markov Chains</td>
<td>Repeat and near-repeat victimisation. Spatial clustering of burglary activity elevates the risk of further residential burglaries in the near future and in close proximity to the initial cluster.</td>
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<tr>
<td>Sidebottom, 2012</td>
<td>Malawi</td>
<td>2004-2005</td>
<td>Residential burglary</td>
<td>Correlational analysis</td>
<td>Repeat victimisation. Seemingly wealthier residences experience higher rates of repeat victimisation. This pattern is most pronounced in areas that are, on average, less affluent.</td>
<td></td>
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<tr>
<td>Sorg et al., 2017</td>
<td>USA</td>
<td>2009</td>
<td>Police-initiated activities</td>
<td>Analysis of covariance (ANCOVA)</td>
<td>Spatio-temporal variation in hot spot patrolling. The amount of time spent outside assigned areas increases as time goes on. Additionally, this process is hastened in areas that are faced with relatively little crime, or in areas that are adjacent to high-crime areas, a result that is in line with the qualitative predictions of the patch departure model.</td>
<td></td>
</tr>
<tr>
<td>Wang &amp; Liu, 2017</td>
<td>China</td>
<td>2013</td>
<td>Residential burglary</td>
<td>Knox test</td>
<td>Repeat and near-repeat victimisation. The risk of burglary varies in time and space. Clusters of burglary positively impact the risk of victimisation for nearby areas.</td>
<td></td>
</tr>
<tr>
<td>Wheeler, 2012</td>
<td>USA</td>
<td>2003-2008</td>
<td>assault, burglary, robbery, motor vehicle theft, larceny, possession of contraband, and vehicular crime</td>
<td>Regression analysis</td>
<td>Sequential target selection. There is a small effect of offenders changing their residence location on crime location choice. They tend to commit crimes in locations farther away from past offences than would be expected without moving.</td>
<td></td>
</tr>
<tr>
<td>Study</td>
<td>Location</td>
<td>Time Period</td>
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<td>Methodology</td>
<td>Findings</td>
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<td>Youstin et al., 2011</td>
<td>USA</td>
<td>2006-2008</td>
<td>Shootings, motor vehicle theft and robberies</td>
<td>Near repeat calculation, Knox test</td>
<td>There is a demonstrable near-repeat pattern for all studied crime types, though the exact pattern varies across crime types.</td>
<td></td>
</tr>
<tr>
<td>Yu &amp; Maxfield, 2013</td>
<td>USA</td>
<td>2005-2007</td>
<td>Commercial and residential burglary</td>
<td>Regression analysis</td>
<td>The presence of business premises is linked with increased victimisation rates, possibly by helping offenders develop awareness space of the area where the business is located.</td>
<td></td>
</tr>
</tbody>
</table>

¹ It is important to note the distinction between the choice whether or not to engage in illegal activities, or deciding where and when to offend after having made the decision to commit one or more crimes (Cornish & Clarke, 1986). Environmental criminology mainly concerns itself with the latter decision, which means that Fagan and Freeman’s theoretical framework and subsequent applications are not included in this review since its focus lies on the application of OFT in environmental criminology.

² To illustrate, the combination of foraging and crime resulted in approximately 21,800 hits.