An Analysis of Mobility Patterns in Sexual Homicide

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Abstract
This article—based on a national data set (N = 173)—focuses on extrafamilial sexual homicides and their spatial mobility. The study combines the location of the crime scene and the offenders and victims’ residences in mobility crime triangles. The findings reveal that most of the homicides fall within the categories of offender mobility and total mobility. Our results show the validity of the distance decay function, with over 70% of homicides occurring within 10 km of the offender’s residence. It appears that under certain circumstances, sexual murderers perceive their surroundings as a safe place to commit a homicide. Finally, the study proposes a four-category spatial typology of sexual homicide.

Keywords
crime scene, policing, investigation, profiling, stranger, victim/offender relationship, victimization

Introduction
The distance traveled to commit a crime is important not only for theory but also for the investigation of these crimes. Although there has been considerable research on the journey-to-crime, very few studies have focused on sexual crimes. However, the studies that have examined sexual crimes have found that similar to other personal crimes—such as homicide—sex offenders tended to commit their crimes close to home (see, for example, Alston, 1994; Andresen, Frank, & Felson, 2014;

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Beauregard, Proulx, & Rossmo, 2005; Block, Galary, & Brice, 2007; Chopin & Caneppele, 2018, 2019; Davies & Dale, 1995; LeBeau, 1987a, 1987b, 1987c, 1992). Recently, studies have examined the traveling patterns of sexual homicide offenders (see Beauregard & Martineau, 2017; Martineau & Beauregard, 2016). Maybe because sexual homicide is considered a hybrid crime—combining homicide and sexual assault—results were different. For instance, studies have found that sexual murderers may travel further from their residence to the initial contact scene or choose body disposal sites further from home (e.g., Martineau & Beauregard, 2016), suggesting that at least some sexual murderers are willing to travel longer distance when committing their crime. Although interesting, these findings were limited by the measure used for the distance traveled.

Therefore, the aim of this study is to explore three questions related to the distance traveled by sexual murderers. First, the study will describe the mobility of extrafamilial sexual homicide (ESH) by analyzing distances between the offenders’ residences, victims’ residences, and the crime locations. Also, our goal is to classify ESH cases in two pre-existing crime mobility triangle typologies and analyze their heuristic value for ESH. Finally, this research aims to explore the relationship between criminal mobility and individual as well as modus operandi characteristics. In this study, the focus was put on the description of ESH mobility using the triangle mobility methodology as well as the factors associated with it (instead of some of the concepts associated with environmental criminology, such as distance decay, buffer zone, and anchor points).

**Literature Review**

In criminology, the concept of *criminal mobility* usually refers to the distance traveled by offenders from their home to the crime location (i.e., the journey to crime). One recurrent finding arising from the journey to crime literature is that offenders travel relatively short distances when committing their crime. However, Beauregard and Busina (2013) suggested that the use of the journey to crime as the sole measure of criminal mobility comes with several assumptions that are not always met, such as (a) assuming that the home location of the offender is the starting point of the crime trip (i.e., a crime trip may originate from a different location, such as the offender’s workplace; see Bernasco, 2010); (b) assuming that the entire criminal event takes place at the same location, even in cases of crimes involving a mobile human victim (Beauregard, Rebocho, & Rossmo, 2010); and (b) assuming that the concept of mobility can and should only be measured in terms of distance traveled, neglecting the other dimensions of the mobility concept (see Rossmo, Lu, & Fang, 2011).

Due in part to the various limitations reviewed above, complementary approaches to the measure of criminal mobility were suggested. Leclerc, Wortley, and Smallbone (2010) conceptualized geographic mobility as the use of multiple locations for the purpose of repetitive sexual contact with the same victim. In other words, they examined whether offending differences existed between child molesters who used multiple locations for sexual contact and those who used a single location for the entire
crime-commission process. What they found was that the mobile offender is more likely to isolate his victims, use violence, involve the victim in several sexual episodes, abuse the victim for over a one-year period, and make the victim participate in and perform sexual acts during the attack.

Instead of looking at criminal mobility as a dichotomous outcome as in Leclerc et al. (2010), Beauregard and Busina (2013) conceptualized criminal mobility as the number of changes of location within the criminal event (i.e., encounter, attack, crime, and victim release locations). They found that more criminal mobility was observed in events which involved child or adolescent victims, when the offender did not use pornography prior to crime, and where victim resistance was observed. Moreover, crimes in which the victim was targeted or alone when approached by the offender and the assault was characterized by sexual penetration and a lack of premeditation exhibited more criminal mobility.

Finally, based on existing typologies on the spatial behavior of sex offenders and serial murderers, Beauregard et al. (2005) suggested two main types of criminal mobility, the *geographically mobile* and the *geographically stable*. Although interesting, these different measures of criminal mobility have been used on sex offenders in general. Unfortunately, the knowledge on the criminal mobility of sexual murderers has been very scarce.

**Criminal Mobility of Sexual Murderers**

Interestingly, of the four studies examining the criminal mobility of sexual murderers, three of them have focused on sexual murderers of children. Brown, Keppel, Weis, and Skeen (2006) found the distance from the murder scene to the body disposal site was less than 59 m in 72% of the cases and that in 37% of the cases, the body was recovered less than 2.4 km from the victim’s residence. Nethery (2004) found that among Canadian cases, the distance between the victim’s residence and the body recovery location was shorter for child victims (about 10 km) than for adults (about 30 km), and the distance between the victim’s and the offender’s residence was, in 62% of the cases, shorter than 6 km.

More recently, Martineau and Beauregard (2016) examined the journey to sexual homicide as well as the correlates of criminal mobility in a sample of 214 Canadian sexual murderers. After identifying the travelers and the non-travelers (i.e., a traveler had to travel at least 0.5 km between either the initial contact scene and the offense scene or the offense scene and the body disposal site), they investigated the victim, offender, and crime characteristics associated with traveling during the sexual homicide. They found that sexual murderers are more likely to travel when the victim is a child, when targeting a victim who is walking or jogging at initial contact, when encountering a victim in a bar, or when targeting a victim who is working as a sex trade worker at the time of initial contact. As to offender characteristics, sexual murderers who normally drive are more likely to travel during the commission of the crime as well as those who have prior sexual offense convictions. As to the modus operandi, not surprisingly, the use of a vehicle is associated with intra-crime travel
as well as targeting a stranger based on opportunity. Their findings also showed that more cases involving travelers were unsolved compared with cases involving non-travelers.

Regarding the sexual murderers’ mobility, they found that, on average, offenders travel no more than 4 to 5 km between crime scenes. Interestingly, however, sexual murderers may travel further from their residence to the initial contact scene or choose body disposal sites further from home, traveling between 25 and 30 km from their residence to these two locations. However, the significant standard deviation about the mean suggested that at least some sexual murderers are willing to travel longer distance when committing their crime—the range of distances being between 0 and 890 km (e.g., traveling for some other unknown purpose when opportunistically encountering a victim, for the purpose of targeting specific but rare victim types; Rossmo, 2006). These results are congruent with what Davies and Dale (1995) observed with their stranger rapists, some rapists willing to travel distances between 16 and 160 km, or even greater. They suggested that sex offenders committing sophisticated property offenses during a sexual assault, spending large amounts of time roaming and using public transportation, and being familiar with numerous neighborhoods, were more likely to travel longer distances to commit their crimes (Davies & Dale, 1995). Similarly, Bernasco (2010) found that offenders’ past residences could influence the distance they are willing to travel.

Contrary to most criminals, and to sex offenders specifically, sexual murderers travel farther from home to encounter their victim. Sexual murderers travel on average close to 30 km to encounter a victim, whereas the majority of sex offenders keep this distance under 4 km (see Beauregard et al., 2005). Similarly, sexual murderers tend to select body disposal locations that are on average 25 km from their residence (Martineau & Beauregard, 2016). Although the median (1.29 km for distance to initial contact and 1.80 km for distance to body disposal) suggests that most of these offenders do not travel far from home, it also suggests that although not common, some sexual murderers are willing to travel considerable distances from their home to either encounter a victim or dump the body. In fact, the range for these distances is up to 890 km. But because in 60% of cases, the offender did not travel between the initial contact scene and the offense scene and in 70% of cases the distance between the offense scene and body disposal site is zero, this result is a distorted view of the distances traveled by these offenders (Martineau & Beauregard, 2016).

**Mobility Triangle as a Better Measure**

Contrasting with the general approach of the journey to crime, other researchers have examined offenders’ criminal mobility by computing mobility crime triangles (see Amir, 1971; Andresen, Felson, & Frank, 2012; Burgess, 1925; Chopin & Caneppele, 2018, 2019; Groff & McEwen, 2005, 2007; Normandeau, 1968; Tita & Griffiths, 2005). This is achieved by combining the spatial information about the offender’s and victim’s home base as well as the crime scene. Mobility crime triangles have been computed following two typologies: geometric and geographic...
patterns of crime. The geometric pattern of crime is used to give an overview of the spatial distribution (Groff & McEwen, 2005, 2006, 2007). According to Groff and McEwen (2007), three geometric patterns exist in relation to an offender’s and a victim’s journey to crime: dots, lines, and triangles. The dot pattern concerns cases where the three addresses are the same (the offenders’ and victims’ residence and the crime location). This situation does not imply that the offender and the victim were living in the same apartment or that the crime necessarily occurred in the residence of the protagonists (the victim and offender may live in the same building, in separate apartments, and the crime may occur in the hallway or staircase). The line pattern implies that two of the three addresses are at the same geographical location. According to this pattern, the victim may have traveled to the offender’s residence, the offender may have traveled to the victim’s living place, or the offender and the victim lived in the same location and have traveled together to the crime location. Finally, the triangle pattern implies that the three addresses are all at a different geographical location. This classification provides a first approach to examine the relationships between the offender’s residence, victim’s residence, and the crime location (Chopin & Caneppele, 2018; Groff & McEwen, 2005, 2006, 2007).

Following this last pattern, a five-category typology—the geographic pattern of crime—was originally identified by Normandeau (1968). The first type, a neighborhood triangle, described a crime in which all three locations were found in the same neighborhood. The offender mobility triangle described situations in which the victim and crime location are in the same neighborhood, but the offender is from a different neighborhood, while a victim mobility triangle occurs when the victim travels to the offender’s neighborhood and is victimized. The offense mobility triangle describes a situation when the offender and victim live in the same neighborhood, but the crime is committed in another neighborhood. Finally, a total mobility triangle is characterized by the absence of overlap among the neighborhoods containing the three locations.

Tita and Griffiths (2005) adapted Normandeau’s (1968) spatial typology to homicide events. The five-mobility categories were the following: internal, predatory, intrusion, offense mobility, and total mobility types. Without going into the details of each type, it is noteworthy that by combining the two types of homicides involving offenders’ mobility (predatory and total mobility), the authors found that a little more than 60% of all homicides involved nonlocal offenders. Moreover, by combining the intrusion and total mobility types, in more than 46% of homicides, the crime was committed outside of the victim’s census tract. Tita and Griffiths (2005) also showed that only one in every four homicides were local to both the offender and the victim (i.e., internal type). These findings demonstrate that when combining the offender’s residence, the victim’s residence, and the crime scene, these mobility triangles show significant mobility during the crime-commission process. Interestingly, these findings were also replicated by Groff and McEwen (2007). Finally, research (Chopin & Caneppele, 2018, 2019) have confirmed the heuristic value of the mobility crime triangle for extrafamilial sexual assaults of adult and child victims. They found that more
than 75% of all sexual assaults against adult victims involved nonlocal offenders whereas this level is of 50% for cases of child abuses. Compared to Tita and Griffiths (2005), results showed higher mobility levels for sexual crimes than for homicides. They also found that crime characteristics are better predictors of patterns of mobility than individual ones. Although interesting and informative, there is still a lack of research on crime mobility patterns in sexual homicide.

**Aim of Study**

This study presents three main objectives. First, this study aims to describe the mobility of extrafamilial ESH by analyzing distances between the offender’s residence, victim’s residence, and the crime location. The second objective is to test whether ESH cases can be classified according to two pre-existing crime mobility triangle typologies and analyze their heuristic value for ESH. Finally, this research aims to explore the relationship between criminal mobility and individual as well as modus operandi characteristics of ESHs.

**Method**

**Sample**

The sample consists of 173 solved cases of ESH that occurred in France between 1979 and 2018. Following the definition used by Beauregard and Martineau (2012), the homicide cases must be identified as completed murders (i.e., no attempts), involving a sexual element.

The sample comes from a national police database which includes information collected throughout the investigation by various actors (police detective, coroner, psychologist, etc.). To avoid missing data, information is compiled in the database by crime analysts who are experts in extrafamilial violent crimes.

Specifically, cases should include at least one element from the Federal Bureau of Investigation (FBI) definition (Ressler, Burgess, & Douglas, 1988). In the sample, 35.84% of victims \( n = 62 \) were found partially or totally naked, 11.56% of victims \( n = 20 \) had genitals exposed, and 7.51% of victims \( n = 13 \) were found in a sexually explicit position. Foreign object insertion was committed in 14.45% \( n = 25 \) of the cases, vaginal and/or anal penetration with a penis in 57.23% \( n = 99 \) of the cases, and fellatio in 15.03% \( n = 26 \) of the cases. Evidence of substitute sexual activities were found in 16.18% of the cases, and crime scene evidence suggesting sadistic fantasies were found in 33.53% \( n = 58 \) of the cases. It is noteworthy that none of the victims included in the sample were only characterized by being found naked. This characteristic is always combined with at least one of the other criteria of the FBI definition.

The study only included cases for which the three addresses (offender residence, victims residence, and crime location) were available. In all cases included in this study, sexual assaults and murders occurred in the same place.
Procedure

The three addresses have been computed using a geocoding tool. To identify the mobility pattern triangles (Groff & McEwen, 2007), we have calculated the distances from the XY coordinates between the three apexes with the QGIS software. The mobility triangle can be calculated in various ways (e.g., Chopin & Caneppele, 2018, 2019; Groff & McEwen, 2005, 2007). As discussed by Chopin and Caneppele (2018), crime triangle mobility can be divided in two stages. The first stage consists of creating the geometric pattern of crime and represents an exploratory analysis to examine the relationship between the three addresses (i.e., victim residence, offender residence, and crime location). The geometric patterns of crime can be divided into three categories: dots, lines, and triangles (Groff & McEwen, 2006). Dots patterns represent cases where offenses occur at the same address, where both the offender and the victim are living at the time of the offense. With line patterns, two out of the three locations for the crime are the same. Finally, triangle patterns involve cases where the three locations implicated in the crime are different.

The second step of analysis consists to generate the geographic patterns of crime constituting a more comprehensive level of analysis to explore the crime mobility. All categories of this model (i.e., neighborhood pattern, offender mobility pattern, victim mobility pattern, offense mobility pattern, total mobility pattern) are created around the concept of a neighborhood. To operationalize it, we have used the distance of 400 m commonly used in criminological literature on sexual crime and nonsexual homicide (Amir, 1971; Chopin & Caneppele, 2018; Groff & McEwen, 2005, 2006, 2007). Basically, this distance corresponds to the standard distance used in the transit system to identify areas accessible on foot (Aultman-Hall, Roorda, & Baetz, 1997; Boehmer, Hoehner, Wyrwich, Ramirez, & Brownson, 2006; El-Geneidy, Grimsrud, Wasfi, Têtreault, & Surprenant-Legault, 2014; Pikora et al., 2006; Sampson, 1986; Simon, Kwan, Angelescu, Shih, & Fielding, 2008). In the neighborhood pattern, none of the apexes are farther than 400 m. In the second group of patterns, only one apex is farther than 400 m, either for the offender’s residence (offender mobility), the victim’s residence (victim mobility), or the place of crime (offense mobility). Finally, the total mobility pattern describes the cases where the three apexes are all farther than 400 m. Following the procedure used by Chopin and Caneppele (2018), we have analyzed the sensitiveness of this decision by testing other distances (250 m, 500 m, 750 m, and 1 km). Findings (see Appendix A) showed that only cases included in the neighborhood and the total mobility patterns varied according to the lower or higher distances.

Measure

Dependent variables correspond to the different measures of the mobility crime triangle (geometric and geographic patterns). The first cluster of dependent variables corresponds to the geometric pattern of crime, and it is divided in three binary variables (coded in 0-1): dot, line, and triangle patterns. The second cluster of dependent variables measures the geographic patterns. This cluster is divided in five binary variables:
neighborhood mobility, offender mobility, victim mobility, offense mobility, and total mobility.

Two groups of independent variables have been considered. The first group focuses on the individual characteristics of offenders and victims (20 variables). The second group focuses on the modus operandi (25 variables).

Victim. Three sociodemographic variables have been considered: (1) sex, (2) age (less or more than 15 years old), and (3) marital status (single). Five variables examine the lifestyle of the victim at the time of offense: (4) consumption of psychoactive substances (alcohol and/or drug), (5) victim is handicapped (physically and/or psychologically handicapped), (6) victim has an active social life (i.e., victim participates in social events where other people are present), (7) victim is a loner (i.e., victim avoid social contact), and (8) victim is homeless. Finally, four variables examine the routine activities of the victim prior to the crime: victim was assaulted while involved in (9) domestic activities (e.g., watching TV), (10) sleeping, (11) traveling (e.g., walking, jogging, in transit to or from somewhere), and (12) sports or recreational activities.

Offender. Four sociodemographic variables have been used: (12) sex, (13) age, (14) offender is single, and (15) offender living alone. One variable related to sexual behavior has been considered: (16) evidence of paraphilic behavior (offender has been detected to have paraphilia and/or sexual deviance). Finally, four variables measuring the offender’s lifestyle prior to the crime have been included: (17) consumption of psychoactive substances (alcohol and/or drug), (18) offender is handicapped (physically and/or psychologically handicapped), (19) offender has an active social life (i.e., offender participates in social events where other people are present), and (20) offender is a loner (i.e., offender avoid social contact).

Modus operandi. In this study, 25 variables describe the modus operandi. These variables are (1) victim and offender were strangers; (2) victim and offender were acquaintances; (3) offender used con approach (e.g., befriended the victim, posed as an authority figure, offered assistance, etc.); (4) offender used surprise approach (e.g., lay in wait inside a building, grabbed the victim, etc.); and (5) offender used blitz approach (e.g., offender grabbed and immediately choked the victim, offender immediately overpowered the victim, offender immediately hit the victim, offender immediately stabbed or shot the victim, etc.). Variables related to crime locations are (6) witnesses can see the crime; (7) crime occurred in a residence (e.g., victim’s residence, offender’s residence, single-family dwelling, multifamily dwelling, third party residence); (8) crime occurred at a business location; (9) crime occurred at a transportation-related location (e.g., offender’s motor vehicle, taxi, school bus, city bus, subway); (10) crime occurred at an entertainment location (e.g., bar, nightclub, circus, carnival, bowling); (11) crime occurred in a public building (e.g., school, library, hospital, public washroom); (12) encounter, crime, and body recovery occurred at the same location; (13) crime occurred inside; and (14) offender was familiar with the place. Variables used to describe illegal sexual acts during the
crime are (15) sexual penetration (i.e., vaginal and anal penetration with a penis or a foreign object); (16) fondling; (17) foreplay (i.e., fellatio, cunnilingus, masturbation); (18) sexual sadism (e.g., beating sexual areas with hands/fist/object; biting sexual areas, etc.); and (19) unusual acts (i.e., cannibalism, evisceration, skinning victims). Other variables related to the crime are (20) offender was angry; (21) injury severity (high and extreme); (22) physical resistance of the victim; (23) victim has been beaten; (24) presence of weapons; and (25) body has been moved.

Analytical Strategy

The study follows a two-step analytical process. As the first step, we have used a descriptive analytical procedure. First, we have observed the distribution of the three distances (offender–crime location, victim–crime location, and offender–victim). Second, we have linked these three distances to create two typologies: (a) the geometric and (b) geographic patterns of crime. Then we have classified the cases in each cluster of the two abovementioned typologies of mobility crime triangles (i.e., geometric pattern of crime and geographic pattern of crime).

As to the second step, we have used bivariate and multivariate analyses. First, using bivariate analyses (i.e., chi-square and analysis of variance [ANOVA]), we have identified the differences in the distribution of the proportion of independent variables compared to the three categories of the geometric pattern of crime. Thus, we have measured the differences between (a) dots and lines patterns, (b) lines and triangles patterns, and (c) dots and triangles patterns. If the independent variable presented at least one significant difference, it was retained for the multivariate analyses. Second, binomial logistic regressions were used to compare all five categories of the geographic mobility patterns of crime with the rest of the sample.6

Results

Journey to Sexual Homicide

Table 1 describes the distance distribution between offenders’ residences, victims’ residences, and crime location. Most cases are located within a 10-km area. More specifically, 70.52% of cases occurred within a distance of less than 10 km between the offenders’ residence and the crime location. In most cases (90.17%), the distance between victims’ residences and crime locations is less than 10 km. Finally, in most cases (69.36%), victims and offenders lived at a distance less than 10 km.

Figure 1 presents the first 10-km segments of the three distances (see Appendix B for details). There is a general pattern of distance decay. In the majority of cases, offenders are living less than 2.25 km from the crime location. This is similar for the distance between offenders’ and victims’ residences. In 50.4% of the cases, protagonists lived less than 2.25 km away from each other. Finally, in 58.4% of the cases, the distance between the victim’s residence and the crime location was less than 250 m.
By connecting the three addresses of each case, we obtain the two types of mobility crime triangles: the geometric patterns of crime and the geographic patterns of crime (Table 2). For the three categories of the geometric pattern, the majority (75.7%) were included in the triangle cluster. The two others are relatively similar, with 13.9% of cases included in the dot cluster and 10.4% of cases in the line cluster. As the second step, we have computed the geographic patterns of crime. Offender mobility (38.7% of cases) is the biggest cluster, followed by the total mobility pattern (26.6%), the neighborhood pattern (23.1%), the victim mobility pattern (9.3%), and the offense mobility one (2.3%).

**Factors Influencing the Mobility**

Table 3 describes the distribution of individual characteristics (victim and offender characteristics) according to the three categories of geometric patterns of crime (dots, lines, and triangles). We observed that victims who are handicapped (physically and/or psychologically) (Cramer’s $V = 0.31, p < .001$) and homeless (Cramer’s $V = 0.26, p < .001$) have been less often assaulted in triangle pattern than in dot pattern. In cases where victims were assaulted during domestic activities, they are more often found in dot patterns than in line (Cramer’s $V = 0.27, p < .001$) or triangle (Cramer’s $V = 0.35, p < .05$) patterns. On the opposite, cases where victims were assaulted while they were traveling occurred more often (Cramer’s $V = 0.17, p < .05$) as a triangle pattern than in a dot one. When offenders are single, they more often assault their victims in a triangle pattern rather than in a line pattern (Cramer’s $V = 0.18, p < .05$). Finally, offenders with paraphilic behavior assault their victims more often in a line (Cramer’s $V = 0.42, p < .01$) or a triangle pattern (Cramer’s $V = 0.21, p < .01$) rather than in dot pattern.

**Table 1.** Distribution of the Intervals of Distances for the Cases of Sexual Homicides ($N = 173$).

| Distance interval (in km) | Offender–crime scene $n$ | Offender–crime scene % | Victim–crime scene $n$ | Victim–crime scene % | Offender–victim $n$ | Offender–victim % |
|---------------------------|---------------------------|-------------------------|------------------------|----------------------|---------------------|-------------------|
| 0-10                      | 122                       | 70.5                    | 156                    | 90.2                 | 120                 | 69.4              |
| 10-20                     | 18                        | 10.4                    | 5                      | 2.9                  | 20                  | 11.6              |
| 20-30                     | 5                         | 2.9                     | 1                      | 0.6                  | 5                   | 2.9               |
| 30-40                     | 0                         | 0.0                     | 3                      | 1.7                  | 1                   | 0.6               |
| 40-50                     | 4                         | 2.3                     | 1                      | 0.6                  | 4                   | 2.3               |
| >50                       | 24                        | 13.9                    | 7                      | 4.1                  | 23                  | 13.3              |
| Total                     | 173                       | 100                     | 173                    | 100                  | 173                 | 100               |
| Mean (km)                 | 56.1                      | 10.5                    | 58.8                   |                      |                     |                   |
| Median (km)               | 2.1                       | 0.0                     | 2.1                    |                      |                     |                   |
Table 4 presents the findings related to the modus operandi. Cases where victims were assaulted by a stranger occur more often as a triangle pattern rather than as a line (Cramer’s $V = 0.16, p < .05$) or as a dot pattern (Cramer’s $V = 0.37, p < .001$). Offenders more often use a surprise approach to assault their victims when in a dot pattern rather than in a triangle pattern (Cramer’s $V = 0.31, p < .01$). Witnesses are more often present when the ESH follows a triangle pattern rather than a dot pattern (Cramer’s $V = 0.20, p < .05$). Regarding the places of crime, ESHs occurring in a residence more often follow a dot pattern rather than a line (Cramer’s $V = 0.28, p < .05$) or a triangle (Cramer’s $V = 0.29, p < .001$) pattern. However, ESHs that occur at business locations more often follow a line pattern rather than dot (Cramer’s $V = 0.28, p < .05$) or triangle (Cramer’s $V = 0.19, p < .05$) patterns. Cases where victims are

Figure 1. Distance decay function displaying the first 0 to 5 km ($N = 173$).

Table 2. Corresponding Table Between the Two Types of Crime Mobility Triangle Typologies: Geometric and the Geographic Patterns of Crime ($N = 173$).

| Geographic patterns of crime | Dots |   | Lines |   | Triangles |   | Total |   |
|-----------------------------|------|---|-------|---|-----------|---|-------|---|
| n | % | n | % | n | % | n | % | n | % |
| Neighborhood | 24 | 100.0 | 5 | 27.8 | 11 | 8.4 | 40 | 23.1 |
| Offender mobility | 0 | 0.0 | 0 | 0.0 | 67 | 51.2 | 67 | 38.7 |
| Victim mobility | 0 | 0.0 | 11 | 61.1 | 5 | 3.8 | 16 | 9.3 |
| Offense mobility | 0 | 0.0 | 2 | 11.1 | 2 | 1.5 | 4 | 2.3 |
| Total mobility | 0 | 0.0 | 0 | 0.0 | 46 | 35.1 | 46 | 26.6 |
| Total | 24 | 13.9 | 18 | 10.4 | 131 | 75.7 | 173 | 100.0 |
Table 3. Distribution of the Victims’ and Offenders’ Characteristics According to the Geometric Patterns of Crime (N = 173).

|                  | Dots |       | Lines |       | Triangles |       | Cramer’s V/phi |
|------------------|------|-------|-------|-------|-----------|-------|----------------|
|                  | n    | %     | n     | %     | n         | %     | a              |
| Victim Characteristics                      |
| Victim is a female                      | 24   | 13.9 | 18    | 10.4  | 131       | 75.7  |                |
| Victim have less than 15 years old        | 3    | 12.5 | 3     | 16.7  | 15        | 11.5  | 0.06           |
| Victim is single                           | 9    | 37.5 | 9     | 50.0  | 59        | 45.0  | 0.14           |
| Lifestyle                                   |
| Victim has consumed psychotropes           | 4    | 16.7 | 5     | 27.8  | 28        | 21.4  | 0.14           |
| Victim was physically/mentally handicapped | 8    | 33.3 | 2     | 11.1  | 8         | 6.1   | 0.24           |
| Victim liked to socialize/party            | 5    | 20.8 | 2     | 11.1  | 27        | 20.6  | 0.12           |
| Victim was a loner                         | 5    | 20.8 | 2     | 11.1  | 9         | 6.9   | 0.12           |
| Victim was homeless                        | 3    | 12.5 | 1     | 5.6   | 1         | 0.8   | 0.1            |
| Routine activities                          |
| Domestic activities                        | 16   | 66.7 | 5     | 27.8  | 38        | 29.0  | 0.35           |
| Sleeping                                   | 4    | 16.7 | 1     | 5.6   | 7         | 5.3   | 0.16           |
| Traveling to or from somewhere             | 3    | 12.5 | 2     | 11.1  | 42        | 32.1  | 0.01           |
| Sports or recreational activities          | 0    | 0.0  | 1     | 5.6   | 6         | 4.6   | 0.18           |
| Offender Characteristics                   |
| Offender is a male                         | 24   | 100.0| 17    | 94.4  | 130       | 99.2  | 0.18           |
| Age                                         | 30.9± (15-56) | 34.3± (18-50) | 30.1± (16-60) |       |       |
| Offender is single                          | 13   | 54.2 | 5     | 27.8  | 73        | 55.7  | 0.24           |
| Offender living with nobody                | 5    | 20.8 | 5     | 27.8  | 22        | 16.8  | 0.09           |
| Sexual behavior                            |
| Evidence of paraphilic behavior            | 0    | 0.0  | 5     | 27.8  | 28        | 21.4  | 0.42           |
| Lifestyle                                   |
| Offender consumes psychotropes             | 14   | 58.3 | 9     | 50.0  | 73        | 55.7  | 0.06           |
| Offender is physically/mentally handicapped| 0    | 0.0  | 0     | 0.0   | 4         | 3.1   | 0.00           |
| Offender like to socialize/party           | 3    | 12.5 | 0     | 0.0   | 11        | 8.4   | 0.23           |
| Offender is a loner                        | 8    | 33.3 | 4     | 22.2  | 24        | 18.3  | 0.11           |

Note. The “a” indicates dots versus lines; the “b” indicates lines versus triangles; and the “c” indicates dots versus triangles.

1One-way analysis of variance (ANOVA) has been computed, but no significant differences has been found.
2Represent the mean.
3Represent minimum and maximum values.
*p ≤ .1, *p ≤ .05, **p ≤ .01, ***p ≤ .001.

Table 4. Distribution of the Modus Operandi Characteristics According to the Geometric Patterns of Crime (N = 173).

|                  | Dots |       | Lines |       | Triangles |       | Cramer’s V/phi |
|------------------|------|-------|-------|-------|-----------|-------|----------------|
|                  | n    | %     | n     | %     | n         | %     | a              |
| Aggression           | 24   | 13.9 | 18    | 10.4  | 131       | 75.7  |                |
| Relationship between offender and victim  |
| Victim and offender are stranger | 0    | 0.0  | 4     | 22.2  | 82        | 62.6  | 0.31           |

(continued)
Table 4. (continued)

|                              | Dots  | Lines  | Triangles | Cramer's V/phi |
|------------------------------|-------|--------|-----------|----------------|
| Victim and offender are acquaintances | 24    | 100.0  | 14        | 77.8           | 49  | 37.4 | 0.31*** | 0.16* | 0.37*** |
| Type of approach¹             |       |        |           |                |
| Con approach                  | 16    | 66.7   | 14        | 77.8           | 77  | 58.8 | 0.15     | 0.13   | 0.04    |
| Surprise approach             | 5     | 20.8   | 0         | 0.0            | 17  | 13.0 | 0.31***  | 0.13   | 0.07    |
| Blitz approach                | 7     | 29.2   | 2         | 11.1           | 33  | 25.2 | 0.21     | 0.11   | 0.02    |
| Place of aggression           |       |        |           |                |
| Witness                       | 8     | 33.3   | 7         | 38.9           | 76  | 58.0 | 0.07     | 0.13   | 0.20*   |
| Residence                     | 24    | 100.0  | 14        | 77.8           | 75  | 57.3 | 0.28‡    | 0.14†  | 0.29*** |
| Business location             | 0     | 0.0    | 3         | 16.7           | 8   | 6.1  | 0.28‡    | 0.13   | 0.03    |
| Transportation-related location| 0    | 0.0    | 0         | 0.0            | 13  | 9.9  | 0        | 0.12   | 0.13†   |
| Entertainment location        | 0     | 0.0    | 1         | 5.6            | 11  | 8.4  | 0.18     | 0.04   | 0.12    |
| Public building               | 0     | 0.0    | 0         | 0.0            | 5   | 3.8  | 0        | 0.07   | 0.08    |
| Meet and aggression at same place | 17   | 70.8   | 7         | 38.9           | 54  | 41.2 | 0.29‡    | 0.02   | 0.20*   |
| Inside                        | 24    | 100.0  | 14        | 77.8           | 71  | 54.2 | 0.28‡    | 0.15†  | 0.31*** |
| Offender is familiar with the place | 22   | 91.7   | 17        | 79.4           | 67  | 51.2 | 0.11     | 0.28***| 0.27*** |
| Type of sexual aggression²    |       |        |           |                |
| Sexual penetration            | 16    | 66.7   | 7         | 38.9           | 76  | 58.0 | 0.25‡    | 0.13   | 0.04    |
| Fondling                      | 8     | 33.3   | 6         | 33.3           | 39  | 29.8 | 0.01     | 0.02   | 0.02    |
| Foreplay                      | 7     | 29.2   | 3         | 16.7           | 61  | 46.6 | 0.13     | 0.20‡  | 0.14†   |
| Sexual sadism                 | 9     | 37.5   | 7         | 38.9           | 42  | 32.1 | 0.03     | 0.05   | 0.03    |
| Unusual acts                  | 3     | 12.5   | 4         | 22.2           | 15  | 11.5 | 0.14     | 0.1    | 0       |
| Anger                         | 21    | 87.5   | 10        | 55.6           | 90  | 68.7 | 0.31***  | 0.1    | 0.12    |
| Injuries severity (high and extreme) | 12   | 50.0   | 6         | 33.3           | 43  | 32.8 | 0.15     | 0      | 0.11    |
| Physical resistance of the victim | 5     | 20.8   | 3         | 16.7           | 42  | 32.1 | 0.04     | 0.11   | 0.09    |
| Blows                         | 11    | 45.8   | 4         | 22.2           | 58  | 44.3 | 0.23     | 0.15†  | 0       |
| Presence of weapon            | 17    | 70.8   | 11        | 61.1           | 89  | 67.9 | 0.07     | 0.05   | 0       |
| Body has been moved           | 5     | 20.8   | 6         | 33.3           | 29  | 22.1 | 0.15     | 0.08   | 0.02    |

Note. The “a” indicates dots versus lines; the “b” indicates lines versus triangles; and the “c” indicates dots versus triangles.

¹Total can be more than 100% if two approaches are combined (e.g., con + surprise).

²Total can be more than 100% if different types of sexual acts are committed during the aggression.

*p ≤ .1. *p ≤ .05. ***p ≤ .01. ****p ≤ .001.

assaulted at the same location than the meeting place more often follow a dot pattern rather than line (Cramer’s V = 0.29, p < .05) or triangle patterns (Cramer’s V = 0.20, p < .05). Similarly, crimes occurring inside and where offenders are familiar with the crime location follow a dot pattern. As to the type of sexual acts committed during the ESH, foreplay less often follow a line pattern than a dot pattern (Cramer’s V = 0.20, p < .05). Finally, regarding the behavior of offenders during the crime, anger is more often present when the ESH follows a dot pattern rather than a line pattern (Cramer’s V = 0.31, p < .01).

Table 5 presents the results of the multivariate analyses conducted for each category of the geographic patterns of crime. ESHs occurring in a neighborhood pattern represent 23.1% of the cases. This pattern is more likely to happen when victims and offenders are acquaintances (β = 2.40, p < .05). Offenders use the surprise approach more often (β = 2.22, p < .05); they assault their victims inside (β = 2.41, p < .01);
Table 5. Logistic Regressions of Factors Influencing the Geographic Patterns of Crime ($N = 173$).

| Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
|---------|---------|---------|---------|---------|
| **Neighborhood** | **Offender mobility** | **Victim mobility** | **Offense mobility** | **Total mobility** |
| **mobility pattern** vs. other cases | pattern vs. other cases | pattern vs. other cases | pattern vs. other cases | pattern vs. other cases |
| β | Exp (β) | β | Exp (β) | β | Exp (β) | β | Exp (β) | β | Exp(β) |
|---|---|---|---|---|---|---|---|---|---|
| Victim was traveling to or from somewhere | 0.84 | 0.43* | 1.50 | 0.22* | 0.89 | 2.44* | 0.78 | 2.18* | 2.44 | 0.09* | 0.88 | 0.42* |
| Offender is single | 1.54 | 4.65* | 1.59 | 4.92* | 2.04 | 7.74** | 3.96* |
| Victim and offender are acquaintances | 2.40 | 11.02* | 2.40 | 11.02* | 1.59 | 4.92* | 2.04 | 7.74** | 3.96* |
| Surprise approach | 2.22 | 9.21* | 2.22 | 9.21* | 2.22 | 9.21* | 2.22 | 9.21* | 2.22 | 9.21* |
| Residence | 2.22 | 9.21* | 2.22 | 9.21* | 2.22 | 9.21* | 2.22 | 9.21* | 2.22 | 9.21* |
| Meet and aggression at same place | Inside | Inside | Inside | Inside | Inside |
| Offender is familiar with the place | 2.41 | 11.43*** | 2.41 | 11.43*** | 2.41 | 11.43*** | 2.41 | 11.43*** | 2.41 | 11.43*** |
| Anger | 1.38 | 3.96* | 1.38 | 3.96* | 1.38 | 3.96* | 1.38 | 3.96* | 1.38 | 3.96* |
| Constant | −7.73 | 0.00*** | 2.21 | 1.23* | 4.21 | 0.01*** | 1.82 | 0.16* | 0.50 | 1.65* |
| 2 log likelihood | 96.816 | 188.943 | 88.720 | 31.925 | 127.235 |
| Cox and Snell $R^2$ | .41 | .19 | .09 | .06 | .36 |
| Nagelkerke $R^2$ | .61 | .26 | .21 | .18 | .50 |
| Overclassification | 85.5% | 70.5% | 90.8% | 97.7% | 82.7% |

*p ≤ .1, **p ≤ .05, ***p ≤ .01, ****p ≤ .001.
and they are familiar with the crime scene ($\beta = 1.59, p < .05$). Offenders following this pattern are more likely to be angry ($\beta = 1.38, p < .05$).

The offender mobility pattern represents the biggest cluster (38.7% of cases). Victims who have been assaulted following this mobility pattern present less risk to be assaulted while traveling ($\beta = -0.84, p < .05$). The crimes occur less often in residence ($\beta = 0.78, p < .05$), and offenders are less familiar with the crime location ($\beta = -1.59, p < .001$).

The victim mobility pattern represents 9.3% of the cases. In this pattern, victims have traveled (consciously or not) near the offenders’ residence. However, victims present less risks to be assaulted while traveling ($\beta = -1.50, p < .05$). Offenders are more often single ($\beta = 1.54, p < .05$) and are more likely to be familiar with the crime location ($\beta = 2.04, p < .01$).

The offense mobility pattern includes only 2.3% of cases. These crimes present less risks to occur in residences ($\beta = -2.44, p < .05$).

Finally, the last category—total mobility pattern—represents 26.6% of the cases. Following this pattern, victims present more risks to be assaulted while traveling ($\beta = 0.89, p < .05$) and the offenders and victims are less often acquaintances ($\beta = -1.19$, $p < .05$).
The aggression occurs less often in residence ($\beta = -1.46, p < .01$) and at the same place where the offender and the victim have met ($\beta = -0.88, p < .05$).

**Discussion**

**Journey to Sexual Murder**

This research investigated the distances between the victims’ and offender’s residences and the crime location. Results showed that in most cases, the three geographical points are within 10 km and—as we hypothesized—they followed a distance decay pattern identified by the literature on extrafamilial sexual crimes (Alston, 1994; Beauregard et al., 2005; Chopin & Caneppele, 2018; Davies & Dale, 1995; LeBeau, 1987a, 1987b, 1987c; Van Patten & Delhauer, 2007). The mobility of ESH was concentrated mostly within an area of 10 km, as found by Nethery (2004). Compared to sexual assaults (Chopin & Caneppele, 2018), ESHs tend to be more concentrated around victims’ and offenders’ addresses. In more than 50% of the cases, the distances between the offenders’ and victims living places and, the crime locations are less than 2.25 km. More than 50% of the victims of ESHs are killed in or immediately around their residence (less than 250 meters) compared to the sexual assaults (more than 50% less than 750 meters). These results confirm the hypothesis suggested by Chopin and Caneppele (2018) that offenders perceive victim’s residence or their surroundings as a safe place to commit and complete sexual assaults. This could suggest that the more serious the sexual crime, the more likely offenders will be to choose a private environment to commit his crime. When comparing the mean distance between sexual assault and ESH, we observe a bigger dispersion for the latter group. The mean distance between the offender-crime location is 56.1 km for ESH cases, compared to 35.9 km for sexual assaults (Chopin & Caneppele, 2018). These results are in line with those of Martineau and Beauregard (2016) who suggested that sexual murderers travel farther than other sex offenders to encounter their victims (Martineau & Beauregard, 2016).

Distance variations may also be observed for victim and crime location (with a mean of respectively 58.8 versus 27.68 km). The variance distribution supports the hypothesis that sexual murderers may be grouped into travelers and non-travelers (Martineau & Beauregard, 2016) and that the latter represent a smaller group. Thus, it is likely that the majority of sexual murderers are non-travelers because the killing was not planned or because they perceived the effort unnecessary or disproportionate.

**Mobility Crime Triangles for Sexual Murder**

By linking the three distances, mobility crime triangles have been computed. Two mobility triangle typologies have been considered: The geometric and geographic ones. In both cases, mobility patterns proved to be useful to analyze ESH. Based on the geometric typology, most cases follow the triangle cluster (75.7%). Compared to the classification of sexual assaults, triangle patterns are similar whereas dots and lines patterns are different. Compared to sexual assaults (Chopin & Caneppele, 2018),
ESHs follow more often a neighborhood pattern (23.1% vs. 11.8%) and less often the total mobility pattern (26.6% vs. 42.8%).

**Modus Operandi and Individual Characteristics for ESH**

Previous studies on sexual assaults (Chopin & Caneppele, 2018) have suggested that the role of modus operandi was more important than offender and victim characteristics in explaining variance in mobility patterns. The results on ESH confirm these results only partially. Based on the geometric patterns, having a paraphilia and being single are two offender’s characteristics that explain variance in some mobility patterns. Intuitively, specific personal victim conditions (e.g., presenting a physical or psychological handicap, being homeless) are more likely to be found in patterns with limited spatial mobility. Some modus operandi characteristics affect the variance of mobility patterns as well. When offenders and victims are strangers, ESHs more often follow a triangle pattern.

Similar suggestions come from the analysis of the geographic mobility patterns and factors associated (Table 6). When the spatial mobility remains at a neighborhood level, we observe that more often, victims and offenders are acquaintances (and familiar with the place), the homicide was committed inside using a surprise approach, and with anger. Paradoxically, following the victim mobility pattern, the aggression is less likely while the victim is traveling to or from somewhere. A possible explanation is that sexual murderers, which in this specific context are usually single, approached their victims at recreational places (crime generators or crime attractors) which they know well since they spend time there (Brantingham & Brantingham, 1995). Victims, who have traveled there to spend their free time, may be under the influence of drugs/alcohol and then they are less able to protect themselves. In the rare cases that ESHs happened farther from the offender’s and victim’s residences (offense mobility), it is less likely that the aggression occurs in a residence since both are far from home. This risk factor is present in the total mobility patterns which reflect a predatory style of aggression, apparently less planned and more opportunistic than the traditional predatory style. Indeed, in this type of mobility pattern, the victim is not acquainted to the offender. S/he is approached while s/he was traveling from or to somewhere, and then the aggression happened at a different place, which is not a residence.

**Toward a Spatial Typology of ESHs**

Our findings allow to further formulate the spatial pattern of ESH. Starting from the distinction of travelers/non-travelers made by Martineau and Beauregard (2016), we hypothesize that ESHs may be grouped in four spatial pattern types. The first type is **Farming**. This is typical for SH between acquaintances. When the victim and the offender are acquaintances, usually they live close to each other and the ESH is committed in a residence from the same neighborhood. In this case, there is evidence of anger at the crime scene which suggests that the homicide could be considered as an extreme reaction to a frustration (e.g., refusal to have a sexual intercourse). The second
type is **Hunting**. In this type, the offender is ready to travel beyond his neighborhood to look for targets and to attack them while they are in their residence. There is no previous relationship between the victim and the offender. Usually the offender studies the victims’ routine activities for a while before acting. The third type is **Trapping**. In this type, the victim travels into the offender’s neighborhood. The victim and offender do not know each other and the meeting place is often a recreational place. The offender chooses his victims according to their individual characteristics and according to the environmental opportunities. Finally, the fourth type is **Picking**. In this type, the offender and the victim are both far from their residence and they do not know each other. Usually, the offender meets the victim while s/he was traveling and then take her or him to a different location to commit homicide.

**Conclusion**

In this study, we analyzed the mobility patterns of 173 ESHs and tested whether these patterns were influenced more by individual characteristics or by the modus operandi. Our results, in accordance with previous research, confirm that studying crime mobility provides further elements to the comprehension of offense characteristics. Compared to other crimes (i.e., sexual crimes, homicides), journeys to ESH are generally shorter, but they follow a distance decay pattern which is very similar to sexual crimes.

Mobility patterns of ESH present more spatial concentration compared to extrafamilial sexual assaults. Although several individual and modus operandi characteristics are associated with the mobility variance, we cannot fully confirm our hypothesis that modus operandi characteristics are more important to understand spatial patterns in ESH. On the contrary, our findings support the hypothesis of the existence of several types of ESHs based on their different spatial patterns.

From a methodological perspective, the use of the geometric patterns of crime provides a first level of analysis confirming the importance of offender–victim relationship to predict spatial behaviors (i.e., stranger ESH occurs more often in triangle mobility whereas acquaintance ESH occurs more often in dot and line patterns). However, as suggested by previous research (Chopin & Caneppele, 2018, 2019; Groff & McEwen, 2005, 2006, 2007), geographic typology of crime provides more comprehensive information.

The results of this study provide interesting implications for both theory and practice. In terms of theoretical implications, this study confirms the fact that ESHs present similar spatial behaviors with sexual offenders compared to nonsexual murderers, confirming conclusions of previous studies comparing these different types of crime (e.g., Beauregard, DeLisi, & Hewitt, 2018; Chopin & Beauregard, 2019). Our findings also confirm that ESHs are not randomly distributed in space and that individual and modus operandi characteristics impact spatial behavior of ESHs. The results obtained in this study also present practical implications, especially for the criminal investigation. Based on the modus operandi and victim characteristics associated with mobility patterns, investigators can adapt their investigative strategies by prioritizing their working hypothesis. The findings may also contribute to the
prioritization of suspects, focusing the search of an offender to certain area depending of their likely spatial pattern. Finally, our findings provide an operational four-category typology (i.e., farming, hunting, trapping, and picking) that can be used as a decision-making tool by police forces.

This study is not without its limitations and the use of police data can lead to bias in data interpretation (see, for example, Aebi, 2006; Chopin & Aebi, 2017; Chopin & Aebi, 2018). First, our study is based only on cases known by the police, and they cannot be generalized to crimes not reported. Official statistics concerning ESH do not exist in France, but Aebi and Linde (2012) indicated that the number of homicides reported to the police is very important in Europe while Chopin (2017) evaluated a police-reported rate of 16% for extramural rapes. Second, in all solved cases included in our study, the sexual assaults and murders occurred at the same location. It is possible that unsolved cases or cases where victims were sexually assaulted and killed at two distinct locations provide different spatial patterns. Third, partly due to the absence of a legal definition for ESH (Roberts and Grossman, 1993), it is possible that some cases of ESH were not identified by the police and consequently were not included in this analysis. Fourth, the analyses included ESHs committed between 1979 and 2018. It is possible that over this period of 40 years, changes in mobility habits have influenced spatial patterns and modus operandi. Fifth, it is important to keep in mind that the spatial patterns identified are incomplete as the current data were only able to reconstruct a portion of their spatial patterns and is based only on limited anchor points (i.e., offenders’ residences, victims’ residences, and the crime locations). For example, the current data did not provide where the victim and the offender worked or where they met before the homicide. We also only considered where the crime took place and not necessarily where victims’ bodies were recovered (i.e., in the situation where the two addresses were different), contrary to the study by Martineau and Beauregard (2016). Sixth, geographic patterns of crime were based on a theoretical construct, following previous studies and based on the classical 400-m distance. This choice was made to provide a better comparison between our findings and those focused on sexual assaults (Amir, 1971; Chopin & Caneppele, 2018, 2019) as well as nonsexual homicides (Groff & McEwen, 2007). Despite the fact that we have tested other distances to operationalize the neighborhood concept, we cannot exclude the possibility that another choice could be more appropriate for ESHs in the French context. Finally, in this study we tested an important number of independent variables ($n = 44$) for a limited sample size ($n = 173$), which can lead to type 1 error. Although using Bonferroni correction is one way to avoid the type of error, our study is exploratory in nature and is not meant to test specific hypotheses. Bonferroni correction is a very conservative procedure that has been criticized for increasing the risk of type 2 errors (see, for example, Napierala, 2012; Simes, 1986; Streiner & Norman, 2011), especially in the context of an exploratory study. Furthermore, we have conducted multivariate analyses following these multiple comparisons at the bivariate level, reducing the impact of potential type 1 errors.

Future studies should focus on whether the changes in mobility patterns over the last decades have changed spatial patterns of ESH. Additional research is also needed
to compare whether mobility patterns are different across ESH, nonsexual homicide, and sexual assault. Finally, the study of criminal mobility should consider more information on the background history of the victim (e.g., previous victimization), the offender (previous criminal record), and the various locations (e.g., previous crimes committed). This could allow to deepen our knowledge on the correlates of spatial patterns in sexual crimes.

**Appendix A**

Geographic Mobility Patterns Distribution With 250, 500, 750, and 1000-m Distances to Operationalize the Neighborhood Concept (N = 173).

| Distance (m) | Neighborhood Pattern | Offender Mobility Pattern | Victim Mobility Pattern | Offense Mobility Pattern | Total Mobility Pattern | Total |
|--------------|----------------------|---------------------------|------------------------|-------------------------|-----------------------|-------|
| 250          | 33 n 19.1%           | 67 n 38.7%               | 17 n 9.8%             | 4 n 2.3%               | 52 n 30.1%           | 173 n 100.0% |
| 500          | 44 n 25.4%           | 68 n 39.3%               | 15 n 8.7%             | 4 n 2.3%               | 42 n 24.3%           | 173 n 100.0% |
| 750          | 42 n 24.3%           | 68 n 39.3%               | 12 n 6.9%             | 4 n 2.3%               | 37 n 21.4%           | 163 n 94.2% |
| 1000         | 55 n 31.8%           | 70 n 40.5%               | 12 n 6.9%             | 4 n 2.3%               | 32 n 18.5%           | 173 n 100.0% |

**Appendix B**

Distance Distribution From 0 to 10 km (N = 173).

| Km       | Offender–place of crime | Victim–place of crime | Offender–victim |
|----------|-------------------------|-----------------------|----------------|
|          | n          | % Cum | n          | % Cum | n          | % Cum |
| 0-0.25   | 52 n 30.1% |         | 101 n 58.4% |       | 49 n 28.4% |       |
| 0.25-0.5 | 7 n 34.1%  | 12 n 65.3% | 6 n 31.9% |       |
| 0.5-0.75 | 5 n 37.0%  | 7 n 69.4%  | 4 n 34.2% |       |
| 0.75-1   | 4 n 39.3%  | 5 n 72.3%  | 0 n 34.2% |       |
| 1-1.25   | 3 n 41.0%  | 4 n 74.6%  | 6 n 37.7% |       |
| 1.25-1.5 | 6 n 44.5%  | 1 n 75.1%  | 7 n 41.7% |       |
| 1.5-1.75 | 6 n 48.0%  | 3 n 76.9%  | 6 n 45.2% |       |
| 1.75-2   | 1 n 48.6%  | 1 n 77.5%  | 5 n 48.1% |       |
| 2-2.25   | 3 n 50.3%  | 0 n 77.5%  | 4 n 50.4% |       |
| 2.25-2.5 | 3 n 52.0%  | 0 n 77.5%  | 2 n 51.5% |       |
| 2.5-2.75 | 4 n 54.3%  | 3 n 79.2%  | 5 n 54.4% |       |
| 2.75-3   | 3 n 56.1%  | 0 n 79.2%  | 2 n 55.6% |       |
| 3-3.25   | 3 n 57.8%  | 4 n 81.5%  | 2 n 56.7% |       |
| 3.25-3.5 | 2 n 59.0%  | 3 n 83.2%  | 0 n 56.7% |       |
| 3.5-3.75 | 4 n 61.3%  | 2 n 84.4%  | 5 n 59.6% |       |
| 3.75-4   | 2 n 62.4%  | 0 n 84.4%  | 0 n 59.6% |       |

(continued)
Appendix B. (continued)

| Km | Offender–place of crime | Victim–place of crime | Offender–victim |
|----|-------------------------|-----------------------|----------------|
|    | n | % Cum | n | % Cum | n | % Cum |
| 4-4.25 | 0 | 62.4 | 0 | 84.4 | 1 | 60.2 |
| 4.25-4.5 | 0 | 62.4 | 1 | 85.0 | 0 | 60.2 |
| 4.5-4.75 | 1 | 63.0 | 0 | 85.0 | 1 | 60.8 |
| 4.75-5 | 0 | 63.0 | 0 | 85.0 | 0 | 60.8 |
| 5-5.25 | 1 | 63.6 | 1 | 85.6 | 1 | 61.4 |
| 5.25-5.5 | 1 | 64.2 | 1 | 86.1 | 2 | 62.5 |
| 5.5-5.75 | 0 | 64.2 | 2 | 87.3 | 0 | 62.5 |
| 5.75-6 | 1 | 64.7 | 1 | 87.9 | 1 | 63.1 |
| 6-6.25 | 1 | 65.3 | 2 | 89.0 | 0 | 63.1 |
| 6.25-6.5 | 3 | 67.1 | 0 | 89.0 | 3 | 64.8 |
| 6.5-6.75 | 0 | 67.1 | 0 | 89.0 | 1 | 65.4 |
| 6.75-7 | 0 | 67.1 | 0 | 89.0 | 0 | 65.4 |
| 7-7.25 | 0 | 67.1 | 0 | 89.0 | 0 | 65.4 |
| 7.25-7.5 | 2 | 68.2 | 1 | 89.6 | 2 | 66.6 |
| 7.5-7.75 | 1 | 68.8 | 0 | 89.6 | 0 | 66.6 |
| 7.75-8 | 1 | 69.4 | 0 | 89.6 | 0 | 66.6 |
| 8-8.25 | 0 | 69.4 | 0 | 89.6 | 2 | 67.7 |
| 8.25-8.5 | 0 | 69.4 | 0 | 89.6 | 0 | 67.7 |
| 8.5-8.75 | 0 | 69.4 | 1 | 90.2 | 2 | 68.9 |
| 8.75-9 | 0 | 69.4 | 0 | 90.2 | 0 | 68.9 |
| 9-9.25 | 1 | 69.9 | 0 | 90.2 | 0 | 68.9 |
| 9.25-9.5 | 0 | 69.9 | 0 | 90.2 | 0 | 68.9 |
| 9.5-9.75 | 0 | 69.9 | 0 | 90.2 | 1 | 69.4 |
| 9.75-10 | 1 | 70.5 | 0 | 90.2 | 1 | 69.4 |
| Total | 122 | 70.5 | 156 | 90.2 | 120 | 69.4 |

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Notes

1. The process followed to enter data in the database allows to avoid missing data as crime analysts collect the necessary information from investigative files. They know exactly where is the information in the files and where it must be introduced in the database. They are also familiar with how each variable is operationalized. Although it is still possible to have missing values as the information may not always be known by the investigators, this was not the case with the variables examined in this study.

2. Victim’s attire or lack of attire, exposure of the sexual parts of the victim’s body, sexual positioning of the victim’s body, insertion of foreign objects into the victim’s body cavities, evidence of sexual intercourse, and evidence of substitute sexual activity, interest, or sadistic fantasy.

3. Crime location address corresponds to where the crime took place, which may be different from where the offender encountered the victim, where he attacked the victim, or where he abandoned the victim.

4. Addresses were compiled by crime analysts for each case, then we geocoded them and computed distances.

5. https://adresse.data.gouv.fr/csv

6. The choice of binomial regressions instead of multinomial regression is justified due to the limited number of cases included in each category (LeBlanc & Fitzgerald, 2000).

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