The Mobility Crime Triangle for Sexual Offenders and the Role of Individual and Environmental Factors
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Introduction

Since the 1970s, the environmental paradigm in criminology has moved its focus from the distant causes of criminality (e.g., unemployment) to the mechanisms (e.g., modus operandi) of crimes (Jeffery, 1969; Wortley & Mazerolle, 2008; Wortley & Townsley, 2016). The old saying “opportunity makes the thief” suggests the idea of rational offenders who are capable of maximizing their utility — searching for suitable targets — and minimizing costs (Cornish & Clarke, 2014/1986; Felson & Clarke, 1998). Environmental theories have been applied to different levels of analysis and different types of crimes. For example, routine activity theory provides an explanation of crime trends at the aggregate or macro level (Cohen & Felson, 1979), geometric theory of crime (Brantingham & Brantingham, 1993) explains crime clusters at the micro level, and rational choice clarifies when offenders decide to commit a crime and continue their criminal pursuits. These theories have proven to be effective for property crimes and even for crimes that appear to be irrational (e.g., sexual crimes). Indeed, several authors (Beauregard, 2005; Beauregard, Proulx, Rossno, Leclerc, & Allaire, 2007; Leclerc, Beauregard, & Proulx, 2007; Murray, 2007; Wortley & Smallbone, 2010) have shown that the environmental perspective is relevant to sexual crimes and is useful when seeking to understand the offender’s modus operandi. Using this perspective, criminologists have studied the convergence in physical space between the offenders and their victims (Bernasco, 2014) focusing on the offender’s mobility pattern. The geographic mobility of offenders can be referred in various ways, such as the criminal mobility or the journey to crime (Hewitt & Beauregard, 2015). Criminal mobility can be defined as “the distances traveled by offenders from their home to crime locations” (Beauregard & Busina, 2013, p. 2053). According to Bernasco (2014, p. 2), “A crime journey thus contain[s] the complete whereabouts of the
individual between leaving home and returning, provided a crime was committed during the journey."

**Journey to Sexual Aggression**

Several scholars have investigated the distance between the offender’s living place and the scene of crime. Studies have shown that in cases of rape, offenders do not travel far before committing their crimes. For example, Alston (1994) showed in a study based in Canada that serial sexual offenders traveled less than 4.83 km in 75.6% of the cases reviewed. In the United Kingdom, Davies and Dale (1995) found that 76% of offenders committed their crimes in an area less than 8.05 km from their houses. The average travel distance varies between 0.92 km (Andresen, Frank, & Felson, 2014) and 4.02 km and depends on the type of sexual aggression (LeBeau, 1987a, 1987b, 1987c, 1992). Block, Galary, and Brice (2007) found a median travel distance of 3.06 km. Scholars have observed a pattern of distance decay with spatial lag. This space, first identified by Turner (1969), is called the buffer zone. It covers the place and the surroundings close to where the offender lives. Even for sexual crimes, most offenders assault their victims close to but not in their homes (Block et al., 2007; Kent, Leitner, & Curtis, 2006; Rossmo, 1998; Santtila, Laukkanen, & Zappalà, 2007; Warren et al., 1998). While the existing literature has dealt extensively with the issue of offender mobility, the question of victim mobility during the day of their victimization has received little attention (Hodgkinson & Tilley, 2007; Pizarro, Corsaro, & Yu, 2007). Past studies on the topic have specifically investigated the distance traveled by homicide victims (Bullock, 1955; Caywood, 1998; Groff & McEwen, 2007; Messner & Tardiff, 1985; Pizarro et al., 2007; Pokorny, 1965; Rand, 1986; Tita & Griffiths, 2005). The general findings show that the victims are assaulted near their own residences but that they have traveled more than the offenders (Hodgkinson & Tilley, 2007; Rand, 1986; Wiles & Costello, 2000). Following the opportunities approach and the geometry of crime, it is assumed that victims follow the same mobility pattern as offenders.
By linking the addresses of the offender’s and the victim’s residences to the place of the crime, it is possible to investigate the crime mobility triangle (see e.g. Groff & McEwen, 2007). Few studies (Amir, 1971; Andresen, Felson, & Frank, 2012) have investigated the mobility triangle for sexual crimes, integrating relevant data concerning sexual crimes in their analyses. In the field of sexual crimes, Amir (1971, pp. 87-95) shows that for two thirds of rapes (68.5%) in the city of Philadelphia (USA), offenders and victims were living in the same area (five city blocks, that is equivalent to 0.40 km). Offenders were not living in the same vicinity of their victims or the offenses in one quarter of the cases (23.9%), while in 4.1% of them, offenders were living in the same vicinity as their victims even though the offenses occurred farther away. Finally, Amir (1971) found that offenders and their offenses occurred in the same neighborhood in 3.5% of cases. Andresen et al. (2012) investigated the impact of Canadian crimes with one victim and one offender versus crimes with multiple victims or multiple offenders on mobility triangles. Their results show differences between cases of sexual assault involving one offender and one victim and cases with multiple offenders and/or victims where mobility is less important. However, scholars should be mindful that their knowledge about patterns may be partial. Offenders and victims do not necessarily start their journeys from their residences to the scene of crime, and even if this is the case, it is not always possible to know whether they stop at any intermediate locations (Bernasco (2010).

Factors Associated With the Journey to Sexual Aggression
Various studies have tested the link between age and mobility. Generally, results show that younger offenders travel less than older ones (Andresen et al., 2014; Davies & Dale, 1995; Gabor & Gottheil, 1984; Rossmo, Davies, & Patrick, 2004; Warren et al., 1998). For example, according to Andresen et al. (2014), offenders less than 20 years old tend to travel a median distance from 0.26 km to 1.50 km. Concerning offenders over 20 years old, scholars observed a higher concentration for distances from 0.50 km to 2.67 km. This research shows that peak
distances were traveled by offenders in the 20–25 and 55–65 age groups. Few studies have investigated the correlation between the gender of the offender and person’s mobility (Beauregard, Proulx, & Rossmo, 2005). The reason being that the proportion of female offenders is small. Some studies concerning the analysis of gender and various types of crimes have shown that female offenders are more likely to commit their crimes within their houses than male offenders (Groff & McEwen, 2005; Levine & Lee, 2013; Rengert, 1975). For example, Levine and Lee (2013) found that in Manchester (UK), female offenders, who committed violent crimes against others, traveled on average 1.90 km whereas male offenders traveled on average 2.30 km. Meanwhile, marital status appears to provide strong explanatory power for sexual crimes (Ciavaldini, 1999; Gravier, Mezzo, Abbiati, Spagnoli, & Waeny, 2010) and victimization (Chapko, Somse, Kimball, & Massanga, 1999; Newton Taylor, DeWit, & Gliksman, 1998). However, the question of the relation between marital status and distance traveled has hardly been investigated in the field of sexual delinquency. Gabor and Gottheil (1984) found that married offenders traveled farther than others.

Some studies on sexual crime frame the modus operandi according to environmental theories (Beauregard, Lussier, & Proulx, 2005; Leclerc et al., 2007). Modus operandi has been defined by Douglas, Burgess, Burgess, and Ressler (2006, p. 353) as “the actions taken by an offender to perpetrate the offense successfully”. LeBeau (1987a) was one of the first to analyze the modus operandi of sexual offenders and its link with the distance traveled. He observed an association between the methods of approach used by the offenders and the distances they traveled. LeBeau (1987a) found that in cases where victims were sexually assaulted in their residences, the offenders lived close by. Thus, he concludes that to understand the journey to crime, factors associated with the method of approach are more significant than the individual characteristics of the offenders. Duwe, Donnay, and Tewksbury (2008) analyzed the modus operandi of recidivist sex offenders. Their results show that when offenders are strangers to
victims, they tend to travel farther to commit the crime than when they are acquaintances. Indeed, 27.9% of stranger rapists assaulted their victims in their own residences. This proportion increases to 58.8% for rapists who were friends of the family, 73.8% for rapists who were acquaintances, and 80.8% for rapists who were family members. Generally, sexual crimes occurred in places where offenders could be alone with their victims and that are easy to escape from (Ceccato, 2014). Offenders will also search for a location where the risk of being interrupted by a third party is limited (Ceccato, Wiebe, Eshraghi, & Vrotsou, in press; Quinsey & Upfold, 1985). Moreover, analysis has shown that rape and sexual aggression occurs for the most part indoors, to a lesser extent outdoors, and barely in a vehicle (Ceccato, 2014; Deslauriers-Varin & Beauregard, 2010; Hewitt & Beauregard, 2015; Koskela & Pain, 2000; Penttilä & Karthumen, 1990; Quinsey & Upfold, 1985). One study in Stockholm (Ceccato, 2014) has shown that approximately 25% of crimes occur in close proximity to the city center while others happen within 2 km from the victim’s residence or near alcohol selling premises. In another study, Ceccato et al. (in press) analyzed 147 cases of rapes in Stockholm. The results showed that the majority of rapes occurred during the evening and the night, especially during the warmer months of the year. Findings also showed that the mobility and social interaction over time and space are essential to understand the rape victimization (Ceccato et al., in press, p. 22). Keating, Higgs, Willott, and Stedman (1990) discovered that the presence of weapons and the type of sexual act depend on the characteristics of the location where the crime occurs.

**Aim of the Study**

The aim of the present study is threefold. The first objective is to describe the distribution of the distances between a victim’s house and the scene of crime, for cases of extra familial sexual assaults, and to compare them to the distribution of the distances between an offender’s living place and the scene of crime. Based on the literature review, we hypothesize that the journey to crime and the journey to victimization follow a distance decay function. The
second objective of this study is to test the hypothesis that geometric and geographic patterns are observable for extra familial sexual assaults. Finally, the third objective is to identify the most predictable factors influencing each pattern. We hypothesize that mobility patterns are more influenced by environmental than individual/social factors.

Methodology

Sample

The sample considered 1,447 cases of sexual assault, committed in an extra familial context between 1979 and 2013, that have been solved and recorded in a national French police database. This study did not consider sexual homicides because, according to the literature (e.g. Beauregard & Martineau, 2012), these crimes have peculiar characteristics. For similar reasons, we excluded cases of sexual assaults against minors under the age of 15, which in France corresponds to legal sexual majority. Several studies suggest profound differences in the modus operandi of sexual offenders who commit crimes against early adolescents (Chopin, 2017; Ciavaldini, 1999; Gravier et al., 2010; Kaufman et al., 1998). Only crimes that included information about all three key geographic locations (the crime scene, the offender’s residence, and the victim’s residence) were selected. Furthermore, sexual assaults perpetrated by multiple offenders and/or against multiple victims were excluded according to the results of Andresen et al. (2012).

Procedure

The sample of 1,447 cases corresponds to situations of sexual aggression where the three relevant addresses could have been geocoded. It represents 69.10 % of the total number of cases available (N=2,094). With the XY coordinates collected, the distances between the

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1 Relevant addresses were automatically geocoded using the following website: https://adresse.data.gouv.fr/csv. When necessary, addresses were manually geocoded.
points were calculated with QGIS software. This enabled the identification of mobility patterns. According to the literature (Groff & McEwen, 2007), three geometric patterns exist (Appendix A): dots, lines, and triangles. Dots represent cases where the crime happens in the same building where both the offender and victim live. With line patterns, two out of the three addresses are the same. As for the triangle, the three places implicated in the crime are distinct geographic points.

The geometric patterns of crime give an overview of the distribution of sexual crimes according to the distances between the apexes (the offender’s home, the victim’s home, and the place of assault). However, geometric patterns may be translated through the adoption of the distance mobility triangle, which is a typology of geographic mobility (Appendix B). This typology identifies several patterns. In the neighborhood pattern, none of the apexes are farther than 400 m apart. In another 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 aggression (offense mobility). Overall, for the total mobility pattern, all the apexes are farther than 400 m apart. The use of 400 m as a standard distance is common 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, Tétreault, & Surprenant-Legault, 2014; Pikora et al., 2006; Sampson, 1986; Simon, Kwan, Angelescu, Shih, & Fielding, 2008). To test the sensitivity of our choice, following the procedure used by Groff and McEwen (2007), we have compared the 400 m distance to other ones (250 m, 500 m, 750 m and 1 km). In three categories (victim, offender and offense mobility), the frequency distribution is stable (variation less to 10%). In the two others, there is a logical correlation: as far as the standard distance increases, the neighborhood mobility patterns increase as well, while the number of total mobility pattern cases decreases. The influence of the above-mentioned independent variables on mobility (the dependent variable) was tested through a
logistic regression. In order to test all categories of the mobility crime triangle typology, we did not merge the smallest ones (offense and victim mobility patterns). Thus, for each crime mobility type, the findings indicate that characteristics are relevant compared to other types.

**Measure**

Based on the literature about the journey to crime and sexual aggression, we selected the following dependent and independent variables. The dependent variables are crime mobility patterns (geometric and geographic). In order to test the geometric patterns of crime, we considered three dichotomous variables: dots, lines, and triangles. For the geographic patterns, we considered five dichotomous variables: neighborhood, offender mobility, victim mobility, offense mobility, and total mobility patterns.

We took into account two groups of independent variables. The first group is related to the individuals involved and more specifically considers the social characteristics of both, victim and offender. The dichotomous variables are sex, age, marital status, and lifestyle at the time of aggression. The second group is related to the modus operandi and to the environmental characteristics of the sexual assault. For it, the dichotomous variables are the relationship between the offender and the victim at the time of aggression, the method of approach used by the offender, the characteristics of the place of aggression, the type of sexual aggression (penetration, touching, or foreplay) that occurred, and the presence of a weapon during the sexual aggression.

**Analytical Strategies**

Firstly, we observed the distance distribution between the offender and the scene of crime, the offender and the victim, and the scene of crime and the victim. We clustered our data in 10 km by 10 km segments, then observed the distribution of the first 10 km.
Secondly, we investigated differences between the geometric patterns of crime through a bivariate analysis. Due to the three dependent variables, we used Cramer’s V and the Phi coefficient. The goal was to select significant independent variables for the multivariate analysis.

Finally, we used multivariate analysis with logistic regressions to test the influence of the independent variables for each geographic pattern of crime. When dependant variables have more than two categories, it is possible to compute multinomial logistic regressions by comparing a reference category with each of the others (Schwab, 2002). However, to achieve empirical validity, it is necessary to have a sufficient sample size per each category (see e.g. LeBlanc & Fitzgerald, 2000) and a minimum of cases per independent variables. These conditions were not systematically fulfilled. Therefore, although models are less stable, the decision was to conduct a series of binomial logistic regressions to have a better empirical validity with a limited sample (see e.g. Lipsey, 1990).

Findings

Distance Decay for Sexual Crimes

Table 1 presents the distribution of sexual cases by three types of distances: offender residence/victim residence, offender residence/scene of crime, and victim residence/scene of crime. All three paths show a strong concentration within 10 km. When comparing medians, offenders move farther (4.35 km) while victims are assaulted closer to their residences (0.62 km).

(PLEASE INSERT TABLE 1)

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2 Multinomial logistic regression was tested and compared with the binomial logistic regressions. Results indicated similar trends in pattern interpretation. However, the multinomial model limited substantially the number of significant variables, more specifically for the offense mobility and the victim mobility patterns.
Figure 1 shows only the segment 0–10 km. The results suggest that most of the sexual assaults are committed in a space of approximately less than 3 km from a residence. The majority of offenders committed their crimes near their own homes: Half of the assaults (50.31%) occurred in a ray of 2.75 km from their living spaces. Half of the assaults (53.42%) were committed within 750 m of a victim’s living space. In the majority of cases (51.35%), victims and offenders were living at a distance of less than 4.75 km from each other.

(PLEASE INSERT FIGURE 1 HERE)

**Geometric Patterns of Crime: Personal, Modus Operandi and Situational Characteristics of Sexual Offenses**

In our sample, the geometric patterns of crime (Groff & McEwen, 2007) were broken into dots (2.35%), lines (24.95%), and triangles (72.70%). Table 2 shows the victims’ and offenders’ characteristics according to geometric patterns of crime. Generally, individual characteristics are not influenced by different geometric patterns. Women are significantly more assaulted in line (95.84%) and in triangle (94.96%) than in dot pattern. Single victims are less likely to be assaulted in line (42.94%) than in triangle pattern (52.38%).

Concerning the lifestyle of victims, those who have consumed alcohol are more likely to be assaulted in dots pattern (14.70%) than in line pattern (9.10%). Finally, victims with active social lives were more often assaulted in line (15.51%) and in triangle (14.92%) than in dot pattern (2.94%). Alcohol consumption by offenders occurs more often in dot pattern (41.18%) than in either line (27.15%) or triangle (27.28%).

Table 3 shows the modus operandi characteristics according to the geometric patterns of crime. The results show stronger differences across geometric patterns than across individual

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3 See Appendix C for a table with all relevant figures.
characteristics. Considering the relationship between the offender and the victim at the time of the assault, victims and offenders were more often strangers in line (68.14%) and triangle pattern (75.67%) than in dot (29.41%). Acquaintance relationship is highly correlated with the dot pattern. With regard to the assault approach, there is only one significant difference concerning the surprise approach, which is more present in the line pattern (35.73%). Meanwhile, the crime scene is sensitive to geometric patterns. Crimes that occurred at home present a dot pattern (91.18%) or a line pattern (79.78%) whereas crimes committed in triangle pattern are more likely to occur in business location (12.07%), transport-related location (13.50%) entertainment location (6.46%) and public building (8.46%) than in line pattern. Concerning the crime scene, crimes committed outside a residence are more often triangle pattern (53.61%), and offenders who assaulted their victims are more familiar with the place of crime in dot pattern (97.06%). With regard to the type of sexual aggression, sexual penetration occurred more frequently in dot pattern (79.41%) than in the others. However, other types of sexual aggression do not differ significantly. Finally, in triangle pattern, offenders were more likely to carry weapons (27.57%).

(PLEASE INSERT TABLE 2 HERE)

(PLEASE INSERT TABLE 3 HERE)

From Geometric Patterns to Distance Mobility Patterns

The geometric patterns of crime present the distribution of sexual crimes according to the distance among the apexes (the offender’s home, the victim’s home, and the place of assault). However, geometric patterns can also yield more information once translated to
distance mobility triangles (Groff & McEwen, 2007). Table 4 shows the corresponding pieces of information for geometric shape and geographic displacement typology.

(PLEASE INSERT TABLE 4 HERE)

Factors Influencing the Mobility Triangle Pattern

To understand the relationship between mobility triangle patterns and the factors associated with them, we conducted a comparison through a series of binomial logistic regressions (Table 5). Sexual crimes committed in the neighborhood pattern represent 11.82% of the sample. In this pattern, victim and offender are more often acquaintances, and assaults happen more likely in a residence. Sexual crimes committed in the offender mobility pattern represent 33.10% of the sample. In this pattern, victim and offender are more often strangers, assaults happen more likely in a residence (we can posit the hypothesis that it would be the victim’s home) and less likely in business locations or entertainment places. With regard to the victim’s characteristics, people less than 20 y/o are at greater risk of assault. Male victims and victims who have consumed drugs at the time of the assault have a lower risk of assault compared to the other mobility patterns. The use of con to initiate the assault is also less likely. The victim mobility pattern represents 9.54% of the crimes. The risk that a sexual aggression occurs within this mobility pattern decreases when the location is a business or when it is close to means of transport. An assault by a stranger is less frequent and less likely to involve a victim younger than 20 y/o. Male victims and victims who have consumed alcohol are at higher risk of being sexually attacked while offenders are 50% less likely to be intoxicated (drugs). In this pattern, sexual offenders are more likely to use a con approach and they are also more likely to be familiar with the scene of the crime and to engage in foreplay. The offense mobility pattern represents a small part of our sample (2.76%). The risk that sexual crimes occur in this mobility
pattern is higher when the victim is male, has consumed drugs, and when the crime occurs outdoors. However, the risk decreases when victims have consumed alcohol and it also decreases when victims are assaulted by a stranger or when the crime occurs in a business location. Finally, 42.78% of the sample falls into the total mobility pattern. Under this spatial pattern, the risk that sexual crimes occur is higher when the offender is a perfect stranger. This risk is higher for a crime that occurs in a business location, in a transportation location or in an entertainment place. Moreover, the risk increases when offenders have weapons (whether they use them or not) at the time of the assault. When the crime scene is a residence, the risk that the crime fits the total mobility pattern decreases.

(PLEASE INSERT TABLE 5 HERE)

Discussion
This study contributes to the discussion on the journey to crime and journey to victimization by analyzing a French national database on sexual crimes. To the best of our knowledge, this is the first exercise to be conducted on sexual assault on a country-wide basis in Europe. Geocoded data were used to build crime mobility patterns and test whether individual and contextual/situational factors were relevant to the different patterns.

Journey to Crime and Journey to Victimization
Our results confirm international findings (Amir, 1971; Andresen et al., 2012; Beauregard, Proulx, et al., 2005; Block et al., 2007) about the likelihood of sexual offenders acting close to their living places. This outcome is supported by how the distance decay function works for sexual offenders. The distance traveled by more than 50% of the offenders was less than 3 km. It was less than 10 km for 70% of the offenders. Nevertheless, our values indicate
that a higher percentage of offenders are ready to travel farther. Methodologically, these differences have two possible explanations. First, the quality of the sample may have affected the findings. Our study covers solved cases at a country level. Most of the existing literature has used databases at lower administrative levels. Clearly, when offenders are highly mobile, local-level investigations face constraints in solving cases. Second, the nature of sexual assaults is an important factor. Most past studies have focused on different types of sexual assaults (e.g., homicide or rape) and sexual offenders (e.g., serial vs. non-serial).

In addition, the analysis indicates that more than 50% of the victims were assaulted within 0.75 km of their living spaces and that more than one third of them did not leave their residences. These results partially confirm the findings of previous studies (Hodgkinson & Tilley, 2007; Rand, 1986; Wiles & Costello, 2000) with regard to the vulnerability of victims’ living spaces, but they do not corroborate that victims travel more than offenders. A possible explanation is that the literature covered all types of crimes or homicides (Bullock, 1955; Caywood, 1998; Groff & McEwen, 2007; Messner & Tardiff, 1985; Pizarro et al., 2007; Pokorny, 1965; Rand, 1986; Tita & Griffiths, 2005) instead of focusing on sexual assaults. Meanwhile, this study considered a variety of sexual assaults (from sexual touching to rape) committed by acquaintances and strangers. Our results suggest that compared to serial rapists who are strangers (Warren et al., 1998), the search pattern for targets does not compel sexual aggressors to move very far from their residences.

This may affect the concept of the buffer zone. According to the geometry of crime (Brantingham & Brantingham, 1993), the buffer zone is an area close to the offender’s residence where crimes are rarely committed because the risk of being recognized is higher. Buffer zones have been detected for different types of property crimes (Rengert, Piquero, & Jones, 1999) and, in the field of sexual crimes, for rapes committed by strangers (Warren et al., 1998). However, our findings suggest that for sexual aggression, the range of the buffer zone
may vary according to the degree of acquaintanceship. This hypothesis has likely been influenced by the fact that our study included different sexual crimes with a variety of patterns and structures of opportunity. For example, in sexual aggression between acquaintances, offenders and victims are not living far from one another. In such a situation, a buffer zone cannot exist because the offender may perceive his residence (or the victim’s) as a safe environment for perpetrating the attack.

**The Geographic Patterns of Extrafamilial Sexual Assaults**

Geometric patterns of crime combine the three distances (offender-place, victim-place, and offender-victim) in order to provide a clue to mobility patterns. The results revealed that in 2.35% of cases the assault was committed at the place where both the offender and the victim lived. By this, we do not necessarily mean the same apartment but the same building. Line patterns represent 24.95% of the cases. With this pattern, the crime can be perpetrated in the offender’s home or the victim’s home, but it can also occur when the offender and victim are living in the same building and the crime happens in a different place. Finally, 72.70% of the cases had triangle patterns. This implies that the offender’s house, the victim’s house, and the scene of the crime are all situated at different addresses. With regard to individual characteristics, the findings did not show significant differences among the geometric patterns. However, the modus operandi characteristics did have significant differences among the patterns; this has also been observed in literature (Beauregard, Proulx, et al., 2005; Davies & Dale, 1995; LeBeau, 1987a). This means that mobility in sexual crime is explained more by environmental factors than individual ones. For example, according to Duwe et al. (2008), sexual offenders who are strangers to their victims are more mobile than offenders who are acquaintances. Logically, the place of aggression reflects the closeness between offenders and their victims: If they share a closer relationship, the risk that the aggression takes place in one
of their residences is then higher, along with the risk of sexual penetration (Keating et al., 1990). This is consistent with the rational choice perspective (Cornish & Clarke, 2014/1986; Felson & Clarke, 1998) because offenders usually know the residence of someone they are closer to and then deem it a safe environment.

Geometric patterns can provide an initial indication of the type of mobility present in sexual assaults, but they do not allow deep levels of understanding to the same extent as mobility patterns (distances) do. Thus, to enrich this perspective, the triangles from the geometric patterns were transformed into geographic mobility patterns (Groff & McEwen, 2005; Groff & McEwen, 2007). Geographic mobility patterns help characterize sexual aggression according to the mobility of the three crime elements (the offender’s residence, victim’s residence, and place of aggression). With the mobility patterns, it becomes clear that different patterns are linked to different approach strategies. Table 6 summarizes the results of the logistic regressions.

(PLEASE INSERT TABLE 6 HERE)

Comparing our findings to Amir (1971), the French assaults do not occur in the same neighborhood as often as they do in the Philadelphia study, and the total mobility pattern is prevalent. Different hypotheses for this outcome are possible. Methodologically, the differences between the information found in the two databases may depend on the type of offense (rape vs. sexual assault), or on the contextual differences between how people may travel / interact in the US and France. It should also be considered that a national database may encompass sexual assaults with farther distances that a city level database cannot detect.

Meanwhile, we hypothesize that over the course of 40 years, the improvement in accessibility and connectivity in transportation has facilitated people’s mobility, that also
includes offenders mobility. Our results show that in 42.78% of the cases, the offender’s residence, the victim’s residence, and the offense location were farther than 400 m from one another (total mobility triangle). The risk that a crime occurs with a total mobility triangle is positively associated with environments other than the offender’s or the victim’s home (at the workplace, a place of leisure, or a public transport hub). This supports the hypothesis that most of these sexual assaults were opportunity-led, a topic that has been discussed by many authors (Beauregard, 2005; Beauregard et al., 2007; Ceccato et al., in press; Cornish, 1994; Leclerc et al., 2007; Murray, 2007). However, this finding does not imply that the predatory scheme never occurs. The presence of weapons (and of strangers) may suggest that offenders are less familiar with the area and their victims (Ceccato, 2014; Keating et al., 1990). In these cases and according to the rational choice perspective, the offenders may use weapons as a mean of coercion against victims in order to minimize the risk of failure (Cornish & Clarke, 2014/1986).

The offender mobility pattern (33.10%) seems to recall predatory schemes according to the classic definition offered by Rossmo (2000). With this pattern, sexual predators are usually strangers and tend to select young victims (less than 20 years old). These victims are mainly women who are less mobile than their older counterparts. Such offenders prefer to break into their victims’ homes using surprise or coercive (blitz) approaches.

In the neighborhood mobility pattern (11.82%), sexual offenders are often acquaintances. They exploit the relationships they have with their victims in two ways. Their geographic proximity facilitates personal interaction and familiarity with the victim’s environment (Duwe et al., 2008). The established relationship built on trust eases such an offender’s access to the victim’s home for the assault. The safety of the place influences the higher risk of sexual penetration (rape) compared to other sexual assaults, that falls in line with previous research findings (Ceccato, 2014; Keating et al., 1990; Quinsey & Upfold, 1985).
The victim mobility pattern (9.54%) recalls mainly predatory schemes. Indeed, in this pattern, male victims are more at risk of being sexually assaulted. They tend to consume alcohol and are approached through deception (con) in areas that the offenders are more familiar with (Ceccato, 2014). In this pattern, sexual aggression has a higher risk of being characterized by foreplay and an acquaintanceship between the offender and the victim. One possible interpretation for this outcome may be that victims are invited by known offenders to go to places of leisure where they then consume alcohol. As a consequence, the victims become vulnerable targets in environments that are familiar to the perpetrators.

The offense mobility pattern (2.76%) looks similar to the previous one in the sense that male victims are more at risk of assault by an acquaintance. In this case, an offender may lure the victim to a remote outdoor location (in close proximity to a place of leisure) using the excuse of consuming illicit substances. The drug consumption then reduces the victim’s resistance to the sexual aggression while the remote location increases the probability of success. This pattern seems to be linked to homosexual environments.

**Conclusion**

This research on extra familial sexual crimes combined mobility triangles with environmental characteristics. The results suggest the relevance of environmental approaches in modeling criminal sexual patterns.

Our study strongly corroborates the distance decay hypothesis. This pattern has been observed, not only for the distance between the offender and the scene of crime, but also for the distance between the victim and scene of crime and the distance from the offender’s to the victim’s residences. The findings support previous literature on the rationality of criminals and sexual offenders. However, the study did not find evidence of buffer zones around the offender’s residence. Acquaintanceship may explain the mechanism of buffer zone removal: Offenders who are acquaintances tend to assault their victims closer to their residences than
those who are strangers. This suggests various interpretations of rationality according to different offender categories (Cornish & Clarke, 2014/1986). Offenders who are acquaintances decrease their efforts by carrying out assaults in their own neighborhoods and accepting the risk of being recognized. The decision to minimize effort spent during the predatory phase (search and approach) suggests that these offenders are not concerned with the potential fallout after the aggression. Instead, they exploit the acquaintanceship to pressure the victim not to report the assault.

Our results also corroborate the hypothesis that mobility is relevant for extra familial sexual assaults. This mobility can be clustered in geometric and geographic mobility classifications. Compared to the findings of Groff and McEwen (2007), the study confirms the heuristic validity of the mobility triangle pattern with the exception of the offense mobility pattern. The similarity in the offense mobility pattern’s modus operandi to the victim mobility pattern suggests that the two could be grouped into one single category. The study, in accordance with our hypothesis, suggests that environmental factors of crime are more significant than individual ones, when it comes to discriminating between mobility patterns of sexual aggression.

Our findings may have implications for criminal investigations. The existence of mobility patterns allows for the understanding of differences in sexual crimes. With this information, the police can adapt their investigative strategies. Since the environmental aspects of a crime scene are the most easily detectable element for police officers (Chopin & Aebi, 2017), these aspects can support the formulation of investigative hypotheses. Police officers can use environmental characteristics to identify an appropriate search area, and the mobility pattern can help indicate where an offender likely lives.

But this research does have some limitations. The analysis is based on police data and only included cases that were reported, classified, and solved by the police as sexual assaults.
Our dataset contains a variety of sexual assaults, that can affect the geographic mobility patterns when compared to other studies that considered only rapes. The geographic information about places of aggression, the offender’s residence, and the victim’s residence was often available at the street level but did not contain building numbers. The distance between points was calculated with Euclidean distance, that may slightly underestimate the journey to crime. Finally, the study assumes that the offender’s and victim’s residences are the beginning of their journeys, that may not be the case in reality.

Further research should replicate our study with datasets from different countries in order to compare the mobility distribution. A longitudinal analysis may test the hypothesis of mobility variation across decades. Other hypotheses to be tested should focus on comparing different types of sexual crimes. Scholars should enlarge the scope to include young victims (less than 15 years old) in order to complete and compare the heuristic value of mobility for sexual crimes. At the same time, future studies should compare the mobility triangle aspects of sexual homicide and isolate mobility patterns for rape and other sexual assaults to test the existence of differences. Moreover, other scholars should compare our findings against their own by considering the real starting points of the journey to crime or, even better, by moving from a mobility triangle to a polygon that includes more than three initial points (e.g., by using mobile phones or electronic monitoring data). To deepen the knowledge about locations associated with sexual crimes can help scholars redefine the concept of the buffer zone. Such research should be used to test whether this concept varies according to the specific parameters of a crime with regard to the relationship between offenders and their victims.
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Appendix

Appendix A: Geometric mobility patterns of crime

Geometric mobility patterns

P = Place of Crime  O = Offender  V = Victim

Appendix B: Geographic mobility patterns of crime (adapted from Groff and McEwen, 2007)

| Patterns              | Sample distance diagram code |
|-----------------------|------------------------------|
| Neighborhood          | ![Diagram of Neighborhood Pattern](attachment:image) |
| Offender mobility     | ![Diagram of Offender Mobility Pattern](attachment:image) |
| Victim mobility       | ![Diagram of Victim Mobility Pattern](attachment:image) |
| Offense mobility      | ![Diagram of Offense Mobility Pattern](attachment:image) |
| Total mobility        | ![Diagram of Total Mobility Pattern](attachment:image) |
Appendix C: Distribution of the distances between 0 to 10 km (N=1,447)

| Km     | O-Perime | V-Perime | O-V    |
|--------|----------|----------|--------|
|        | n        | % Cum    | n      | % Cum   | n      | % Cum   |
| 0 - 0.25 | 240      | 16.59%   | 592    | 40.91%  | 150    | 10.37%  |
| 0.25 - 0.5 | 105      | 23.84%   | 93     | 47.34%  | 81     | 15.96%  |
| 0.5 - 0.75 | 73       | 28.89%   | 88     | 53.42%  | 66     | 20.53%  |
| 0.75 - 1   | 62       | 33.17%   | 59     | 57.50%  | 59     | 24.60%  |
| 1 - 1.25   | 54       | 36.90%   | 39     | 60.19%  | 50     | 28.06%  |
| 1.25 - 1.5 | 45       | 40.01%   | 31     | 62.34%  | 39     | 30.75%  |
| 1.5 - 1.75 | 35       | 42.43%   | 32     | 64.55%  | 30     | 32.83%  |
| 1.75 - 2   | 34       | 44.78%   | 14     | 65.51%  | 37     | 35.38%  |
| 2 - 2.25   | 35       | 47.20%   | 13     | 66.41%  | 27     | 37.25%  |
| 2.25 - 2.5 | 21       | 48.65%   | 22     | 67.93%  | 31     | 39.39%  |
| 2.5 - 2.75 | 24       | 50.31%   | 15     | 68.97%  | 19     | 40.70%  |
| 2.75 - 3   | 24       | 51.97%   | 22     | 70.49%  | 23     | 42.29%  |
| 3 - 3.25   | 20       | 53.35%   | 15     | 71.53%  | 19     | 43.61%  |
| 3.25 - 3.5 | 19       | 54.66%   | 19     | 72.84%  | 31     | 45.75%  |
| 3.5 - 3.75 | 21       | 56.12%   | 10     | 73.53%  | 20     | 47.13%  |
| 3.75 - 4.25 | 15      | 57.15%   | 9      | 74.15%  | 14     | 48.10%  |
| 4 - 4.25   | 14       | 58.12%   | 14     | 75.12%  | 12     | 48.93%  |
| 4.25 - 4.5 | 13       | 59.02%   | 10     | 75.81%  | 13     | 49.83%  |
| 4.5 - 4.75 | 15       | 60.06%   | 8      | 76.36%  | 22     | 51.35%  |
| 4.75 - 5   | 17       | 61.23%   | 13     | 77.26%  | 20     | 52.73%  |
| 5 - 5.25   | 14       | 62.20%   | 2      | 77.40%  | 12     | 53.56%  |
| 5.25 - 5.5 | 12       | 63.03%   | 10     | 78.09%  | 11     | 54.32%  |
| 5.5 - 5.75 | 12       | 63.86%   | 5      | 78.44%  | 11     | 55.08%  |
| 5.75 - 6   | 7        | 64.34%   | 7      | 78.92%  | 7      | 55.56%  |
| 6 - 6.25   | 10       | 65.03%   | 9      | 79.54%  | 13     | 56.46%  |
| 6.25 - 6.5 | 11       | 65.79%   | 6      | 79.96%  | 8      | 57.01%  |
| 6.5 - 6.75 | 11       | 66.55%   | 11     | 80.72%  | 11     | 57.77%  |
| 6.75 - 7   | 12       | 67.38%   | 3      | 80.93%  | 12     | 58.60%  |
| 7 - 7.25   | 4        | 67.66%   | 9      | 81.55%  | 5      | 58.95%  |
| 7.25 - 7.5 | 2        | 67.80%   | 8      | 82.10%  | 4      | 59.23%  |
| Range   | Count | Percent | Count | Percent | Count | Percent |
|---------|-------|---------|-------|---------|-------|---------|
| 7.5 - 7.75 | 14 | 68.76% | 5 | 82.45% | 14 | 60.19% |
| 7.75 - 8  | 12 | 69.59% | 7 | 82.93% | 13 | 61.09% |
| 8 - 8.25  | 6  | 70.01% | 7 | 83.41% | 10 | 61.78% |
| 8.25 - 8.5 | 6  | 70.42% | 4 | 83.69% | 8  | 62.34% |
| 8.5 - 8.75 | 3  | 70.63% | 5 | 84.04% | 5  | 62.68% |
| 8.75 - 9  | 11 | 71.39% | 3 | 84.24% | 9  | 63.30% |
| 9 - 9.25  | 8  | 71.94% | 2 | 84.38% | 4  | 63.58% |
| 9.25 - 9.5 | 2  | 72.08% | 2 | 84.52% | 8  | 64.13% |
| 9.5 - 9.75 | 8  | 72.63% | 4 | 84.80% | 13 | 65.03% |
| 9.75 - 10 | 4  | 72.91% | 4 | 85.07% | 6  | 65.45% |
| **Total** | 1,055 | 1,231 | 947 |
Tables and Figures

Table 1

Distribution of the intervals of distances for the cases of sexual crimes (N=1,447)

| Distance interval | Offender-Place of crime | Victim-Place of crime | Offender-Victim |
|-------------------|-------------------------|-----------------------|-----------------|
|                   | n           | %       | n        | %       | n        | %       |
| 0 – 10 Km         | 1,055     | 72.91%   | 1,231   | 85.07%  | 947     | 65.45%  |
| 10 – 20 Km        | 178       | 12.30%   | 89      | 6.15%   | 211     | 14.58%  |
| 20 – 30 Km        | 72        | 4.98%    | 33      | 2.28%   | 87      | 6.01%   |
| 30 – 40 Km        | 29        | 2.00%    | 19      | 1.31%   | 42      | 2.90%   |
| 40 – 50 Km        | 20        | 1.38%    | 10      | 0.69%   | 26      | 1.80%   |
| 50 – 60 Km        | 20        | 1.38%    | 3       | 0.21%   | 13      | 0.90%   |
| 60 – 70 Km        | 7         | 0.48%    | 12      | 0.83%   | 15      | 1.04%   |
| 70 – 80 km        | 8         | 0.55%    | 0       | 0.00%   | 13      | 0.90%   |
| 80 – 90 Km        | 5         | 0.35%    | 0       | 0.00%   | 6       | 0.41%   |
| 90 – 100 Km       | 1         | 0.07%    | 2       | 0.14%   | 4       | 0.28%   |
| >100 Km           | 52        | 3.59%    | 48      | 3.32%   | 83      | 5.74%   |
| Total             | 1,447     | 100.00%  | 1,447   | 100.00% | 1,447   | 100.00% |
| Mean (Km)         | 35.85     |          | 45.98   |          | 27.68   |          |
| Median (Km)       | 4.35      |          | 0.62    |          | 2.65    |          |

Figure 1. Distance decay function displaying the first 0-10 kilometers (N=1,447)
Table 2

Distribution of the victims and offenders’ characteristics according to the geometric patterns of crime (N=1,447)

|                     | Dots | Lines | Triangles | Cramer’s V / Phi |
|---------------------|------|-------|-----------|-----------------|
|                     | n    | %     | n         | %               | a    | b    | c    |
| **Victim Characteristics** |      |       |           |                 |      |      |      |
| Victim is a male    | 6    | 17.65% | 15 | 4.16%   | 53 | 5.04% | 0.17*** | 0.02 | 0.09*** |
| Victim is a female  | 28   | 82.35% | 346 | 95.84% | 999 | 94.96% | 0.17*** | 0.02 | 0.09*** |
| Victim between 15 and 20 y/o | 11  | 32.35% | 121 | 33.52% | 329 | 31.27% | 0.01 | 0.02 | 0.05† |
| Single              | 16   | 47.06% | 155 | 42.94% | 551 | 52.38% | 0.02 | 0.08** | 0.02 |
| **Lifestyle**       |      |       |           |                 |      |      |      |
| Victim consumes alcohol | 5   | 14.70% | 33 | 9.10%   | 102 | 9.70% | 0.09† | 0.01 | 0.03 |
| Victim consumes drug | 3    | 8.82%  | 16 | 4.43%   | 38 | 3.61% | 0.06 | 0.02 | 0.05 |
| Victim likes to socialize/party | 1  | 2.94%  | 56 | 15.51% | 157 | 14.92% | 0.10* | 0.01 | 0.07* |
| Victim is itinerant | 0    | 0.00%  | 5  | 1.39%   | 7  | 0.67% | 0.04 | 0.03 | 0.01 |
| **Offender**        |      |       |           |                 |      |      |      |
| Offender is a male  | 34   | 100.00% | 361 | 100.00% | 1049 | 99.71% | 0.00 | 0.03 | 0.01 |
| Offender between 15 and 20 y/o | 7  | 20.59% | 49 | 13.57% | 176 | 16.73% | 0.06 | 0.04 | 0.01 |
| Single              | 22   | 64.71% | 210 | 58.17% | 567 | 53.90% | 0.04 | 0.04 | 0.04 |
| **Lifestyle**       |      |       |           |                 |      |      |      |
| Offender consumes alcohol | 14 | 41.18% | 98 | 27.15% | 287 | 27.28% | 0.14** | 0.00 | 0.07* |
| Offender consumes drug | 7   | 20.59% | 60 | 16.62% | 155 | 14.73% | 0.03 | 0.02 | 0.03 |
| Offender likes to socialize/party | 3  | 8.82%  | 23 | 6.37%  | 79  | 7.51% | 0.02 | 0.01 | 0.01 |
| Offender is a loner | 1    | 2.94%  | 47 | 13.02% | 134 | 12.74% | 0.09† | 0.00 | 0.05† |

Diff sig : *** p≤0.001, ** p≤0.01, * p≤0.05, † p≤0.1

a: Dots vs Lines
b: Lines vs Triangle

c: Dots vs Triangles
Table 3

Distribution of the modus operandi characteristics according to the geometric patterns of crime (N= 1,447)

|                         | Dots n | Dots % | Lines n | Lines % | Triangles n | Triangles % | Cramer’s V / Phi |
|-------------------------|--------|--------|---------|---------|-------------|-------------|-----------------|
| **Aggression**          |        |        |         |         |             |             |                 |
|                         | 34     | 2.35%  | 361     | 24.95%  | 1,052       | 72.70%      |                 |
| **Relationship offender-victim** |        |        |         |         |             |             |                 |
| Victim and offender are stranger | 10 | 29.41% | 246 | 68.14% | 796 | 75.67% | 0.24*** | 0.08** | 0.19*** |
| Victim and offender are acquaintance | 24 | 70.59% | 115 | 31.86% | 256 | 24.33% | 0.24*** | 0.08** | 0.19*** |
| **Type of approach** 1 |        |        |         |         |             |             |                 |
| Con approach            | 21     | 61.76% | 189 | 52.35% | 592 | 56.27% | 0.09†   | 0.03  | 0.02  |
| Surprise approach       | 9      | 26.47% | 129 | 35.73% | 310 | 29.47% | 0.06    | 0.06* | 0.01  |
| Blitz approach          | 6      | 17.65% | 68  | 18.84% | 213 | 20.25% | 0.01    | 0.02  | 0.01  |
| **Place of aggression**|        |        |         |         |             |             |                 |
| Residence               | 31     | 91.18% | 288 | 79.78% | 375 | 35.65% | 0.08    | 0.39*** | 0.21*** |
| Business location       | 4      | 11.76% | 28  | 7.76%  | 127 | 12.07% | 0.04    | 0.07*  | 0.02  |
| Transportation related location | 0 | 0.00%  | 15  | 4.16%  | 142 | 13.50% | 0.03    | 0.13*** | 0.05  |
| Entertainment location  | 0      | 0.00%  | 8   | 2.22%  | 68  | 6.46%  | 0.01    | 0.10*** | 0.03  |
| Public building         | 0      | 0.00%  | 22  | 6.09%  | 89  | 8.46%  | 0.05    | 0.06†  | 0.03  |
|                         | 0.00%  | 0.00%  | 0.00% |         |                 |             |                 |
| Outside place           | 3      | 8.82%  | 74  | 20.50% | 564 | 53.61% | 0.09†   | 0.30*** | 0.16*** |
| Offender is familiar with the place | 33 | 97.06% | 281 | 77.84% | 830 | 78.90% | 0.14*   | 0.01  | 0.08** |
| **Type of sexual aggression** 2 |        |        |         |         |             |             |                 |
| Sexual penetration      | 27     | 79.41% | 239 | 66.20% | 618 | 58.75% | 0.09†   | 0.07** | 0.08** |
| Sexual touching         | 20     | 58.82% | 256 | 70.91% | 711 | 67.59% | 0.08    | 0.03  | 0.03  |
| Foreplay                | 19     | 55.88% | 190 | 52.63% | 568 | 53.99% | 0.02    | 0.01  | 0.06† |
| Presence of weapon      | 4      | 11.76% | 91  | 25.21% | 290 | 27.57% | 0.10*   | 0.02  | 0.07* |

Diff sig : *** p≤0.001, ** p≤0.01, * p≤0.05, † p≤0.1

a: Dots vs Lines
b: Lines vs Triangle
c: Dots vs 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
Table 4

Corresponding table between the geographic shape typology and the geographic displacement typology (N=1,447)

|                      | Dots      |   | Lines      |   | Triangles   |   | Total      |   |
|----------------------|-----------|---|------------|---|-------------|---|------------|---|
|                      | n         | % | n          | % | n           | % | n          | % |
| Neighborhood         | 34        | 100.00% | 72         | 19.94% | 65         | 6.18% | 171        | 11.82% |
| Offender mobility    | 0         | 0.00%  | 231        | 63.99% | 248        | 23.57% | 479        | 33.10% |
| Victim mobility      | 0         | 0.00%  | 50         | 13.85% | 88         | 8.37%  | 138        | 9.54%  |
| Offense mobility     | 0         | 0.00%  | 8          | 2.22%  | 32         | 3.04%  | 40         | 2.76%  |
| Total mobility       | 0         | 0.00%  | 0          | 0.00%  | 619        | 58.84% | 619        | 42.78% |
| Total                | 34        | 2.35%  | 361        | 24.95% | 1,052      | 72.70% | 1,447      | 100.00% |
## Table 5

**Binomial logistic regressions of factors influencing each triangle mobility patterns (N=1,447)**

|                      | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
|----------------------|---------|---------|---------|---------|---------|
| **Neighborhood**     |         |         |         |         |         |
| mobility pattern     |         |         |         |         |         |
| Vs other cases       |         |         |         |         |         |
| **Offender mobility**|         |         |         |         |         |
| pattern              |         |         |         |         |         |
| Vs other cases       |         |         |         |         |         |
| **Victim mobility**  |         |         |         |         |         |
| pattern              |         |         |         |         |         |
| Vs other cases       |         |         |         |         |         |
| **Offense**          |         |         |         |         |         |
| mobility pattern     |         |         |         |         |         |
| pattern              |         |         |         |         |         |
| Vs other cases       |         |         |         |         |         |
| **Total mobility**   |         |         |         |         |         |
| pattern              |         |         |         |         |         |
| Vs other cases       |         |         |         |         |         |

| Factor                              | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
|-------------------------------------|---------|---------|---------|---------|---------|
| Victim is male                      | 0.61    | 0.49*   | 1.75    | 5.80*   | 1.39    | 4.01*   |
| Victim between 15 and 20 y/o        | 0.45    | 1.56**  | -0.27   | 0.76*   | -1.32   | 0.26*   |
| Victim consumes alcohol             | 0.61    | 1.84*   | 0.61    | 1.84*   | -1.32   | 0.26*   |
| Victim consumes drug                | -0.84   | 0.43*   | -0.84   | 0.43*   | 1.85    | 6.37*   |
| Victim likes to socialize/party     | -0.60   | 0.55†   | 1.05    | 2.87*   |
| Offender consumes alcohol           | 0       | 1.05    | 2.87*   |
| Victim and offender are stranger    | -0.96   | 0.38*** | 0.85    | 2.35*** | -0.77   | 0.46*** | -0.96   | 0.38*   | 0.30    | 1.34*   |
| Con approach                        | -0.31   | 0.73*   | 0.70    | 2**     |
| Residence                           | 1.46    | 4.31*** | 1.64    | 5.15*** | 0.70    | 2**     |
| Business location                   | -0.46   | 0.63*   | -0.52   | 0.59†   | -1.12   | 0.32*   | 0.90    | 2.47*** |
| Transportation related location     | -0.89   | 0.41†   | -0.78   | 0.45*   |
| Entertainment location              | -1.15   | 0.31*** | 0.70    | 2**     |
| Outdoor place                       | 0.47    | 1.59†   |
| Offender consumes alcohol           | 0       | 1.59†   |
| Victim is familiar with the place   | 0.13    | 1.13†   |
| Sexual penetration                  | -0.34   | 0.71†   | 0.70    | 2**     |
| Foreplay                            | 0.37    | 1.45†   |
| Any use of weapon                   | 0       | 1.30†   |

| n of the reference category         | 171     | 479     | 138     | 40      | 619     |
| % of the reference category         | 11.82   | 33.10   | 9.54    | 2.76%   | 42.78%  |
| Nagelkerke R²                        | 0.20    | 0.22    | 0.15    | 0.17    | 0.34    |

Diff sig : *** p≤0.001, ** p≤0.01, * p≤0.05, † p≤0.1
Table 6

Risk factors positively and negatively associated to the mobility triangle pattern typologies

|                       | Risk factors positively associated | Risk factors negatively associated |
|-----------------------|------------------------------------|------------------------------------|
| **Neighborhood mobility** | Home aggression | Victim with active social life |
|                       | Sexual penetration | Stranger offender |
|                       |                      | Public transport aggression |
|                       |                      | Foreplay only |
| **Offender mobility**  | Victim less than 20 y/o | Male victim |
|                       | Stranger offender | Drug consumption by the victim |
|                       | Home aggression | Con approach |
|                       |                      | Workplace aggression |
|                       |                      | Leisure place aggression |
| **Victim mobility**    | Male victim | Victim less than 20 y/o |
|                       | Alcohol consumption by the victim | Alcohol consumption by the offender |
|                       | Con approach | Stranger offender |
|                       | Offender familiarity with the place of aggression | Workplace aggression |
|                       | Foreplay only | Public transport aggression |
| **Offense mobility**   | Male victim | Alcohol consumption by the victim |
|                       | Drug consumption by the victim | Stranger offender |
|                       | Outdoor place aggression | Workplace aggression |
| **Total mobility**     | Stranger offender | Home aggression |
|                       | Workplace aggression | |
|                       | Public transport aggression | |
|                       | Leisure place aggression | |
|                       | Weapon | |