



Precursor Events of Sex Crimes in Japan: A Spatio-Temporal Analysis of Reports of Contacts with Suspicious Persons by Target Age Groups

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Abstract

Japanese police agencies treat reports of contacts with suspicious persons as precursor events of more serious sex crimes despite the absence of empirical studies causally linking the two phenomena. Data on sex crimes ($N = 599$) and suspicious person reports ($N = 1,396$) from a large police department were statistically analyzed to examine space-time clustering of the two phenomena. The results confirmed the presence of space-time clustering, although the pattern of elevated sex crime risks varied with the target characteristics. In particular, while areas within 250 meters of the location of a suspicious person incident targeting the group teenagers or older were at a significantly higher risk of a sex crime for a period of two weeks, suspicious person incidents targeting the group elementary school children or younger were not associated with future occurrences of sex crimes. The practical implications and limitations of the current study are discussed.

Keywords: Sex crimes; Spatio-temporal analysis; Near repeat victimizations.

Introduction

Police and other government agencies in Japan recognize that sex crimes targeting women and children are significant crime problems. Their increased efforts to protect these presumably vulnerable victims are clearly illustrated in national governmental reports and policies (Cabinet Council for Crime Control, 2005; National Police Agency, 2005, 2008). Although these reports and policies discuss a variety of crime prevention strategies, what is notable is that they list proactive policing of contacts with suspicious persons targeting children and women as the first crime control measure. That is, the proactive deployment of police officers and aggressive investigations of suspicious person reports are treated as the primary crime prevention tactic. In fact, the National Police Agency recently increased the number of police officers nationwide to create a taskforce that is responsible for such an approach (Cabinet Council for Crime Control, 2005; Daily Police

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News, 2009). The rationale behind such focused policing is that the reports of contacts with suspicious persons can be treated as precursor events of more serious sex crimes targeting children and women.

Quite interestingly, however, the idea of contacts with suspicious persons as precursor events of sex crimes has never been examined empirically; the idea is a preconception and intuition at best among policy makers and the media. Therefore, in light of the lack of empirical evidence supporting the current police practice, this study examines whether or not reports of contacts with suspicious persons act as precursor events of future sex crimes by analyzing police data from a spatial and temporal perspective. In doing so, the current study contributes to criminological research both substantively and methodologically. The immediate policy implication of this study is its rigorous assessment of the validity of the current police practice in Japan. Additionally, by quantifying the spatial and temporal range of future sex crime risks, police departments can efficiently allocate their resources for focused police patrols. Furthermore, an empirical analysis of space-time clustering of crime incidents will deepen the understanding of criminal behavior and crime hot spot formation. In particular, an analysis of Japanese data presented for English audiences contributes to the body of criminological literature by confirming the universality of spatio-temporal clustering of crime incidents in a low crime nation. Finally, the study also makes a methodological contribution by extending an existing method of spatio-temporal crime analysis to a bivariate dimension with multiple crime types.

As a guide to readers, the context of suspicious person reports in Japanese society should be explained. All 47 prefectural police departments have taskforces for crimes targeting women and children as noted above, and they collect and publish information about reports of encounters with suspicious persons on their websites. However, there is no uniform definition of what constitutes suspicious person reports, and the nature of incidents varies substantially. In order to analyze precursor events of predatory sex crimes, this paper limited its analysis to those incidents with actual verbal and/or physical contacts between the offender and victim; thus, simple observations of a suspicious person such as a suspected flasher, for example, are excluded. The encounters need to encompass either actual verbal communications (e.g., luring a child to a car, uttering words with sexual connotations) or minor physical interactions (e.g., grabbing a child by the arm, taking a photo or stalking). That is, the incidents that are analyzed in this study are those not serious enough to be considered as a crime but serious enough to have raised concerns among victims and their parents to report them to the authorities.

Literature review: spatio-temporal analysis of crime

Substantial spatial concentrations of crime incidents have been confirmed by empirical studies and have tremendous practical implications in policing and crime prevention activities. A pioneering study of police data at the address level by Sherman and his colleagues (1989) found a small fraction of addresses generated a vast majority of calls for service. Additionally, in a spatial analysis of burglary in England, Ratcliffe and McCullagh (1998) used Geographic Information Systems (GIS) and found that approximately 15% of burglary victims experienced multiple burglary victimizations. Furthermore, these repeat victimizations at the same addresses accounted for about 32% of the total burglaries in the study area, which illustrate the significance of repeat victimizations for crime control (Farrell, G. & Pease, K. 1993; Pease 1998).

While the vast concentration of repeat victimizations in the spatial domain itself was a staggering finding, another important discovery was that repeat victimizations were clustered in a temporal domain as well. Repeat victimization research has consistently identified that the risk of subsequent victimizations decreased as time passed from the original victimization (Ratcliffe and McCullagh, 1998; Polvi et al., 1990; Polvi et al., 1991). That is, when a house was burglarized, the risk of burglary victimization became the highest soon after the initial incident but it decreased exponentially over time. Polvi and his colleagues (1990) estimated that the risk of a repeat victimization was about 12-15 times higher in the month following the initial victimization incident, and the risk dramatically decreased over time and was only about 2.5 times higher in the second month. Finally, the risk of a repeat victimization was only 1.3 times higher on average in subsequent months.

More recent studies that employed sophisticated analysis techniques developed in epidemiology have also identified a phenomenon called near repeat victimizations (Bowers et al., 2004; Johnson & Bowers, 2004a; Townsley et al., 2003) which means that a series of crime incidents occurs *near* a past crime incident location within a relatively short period of time. Repeat victimizations, as described above, mean the repeated occurrences of crime incidents at the exact *same address* locations; hence, near repeat victimizations that include crime incidents in surrounding locations can be conceptualized as a general form of repeat victimizations. Similar to repeat victimizations, researchers identified particular spatial and temporal risk structure for near repeats; the subsequent victimization risk near the original crime incident location was the highest soon after the original incident, and it decreased with time. For example, empirical studies in England found that the risk of subsequent burglary victimizations was statistically significantly higher within 400 meters of an original burglary incident for up to two months (Bowers et al., 2004; Johnson & Bowers, 2004a).

Interestingly, existing empirical studies have found that near repeat victimization is a universal phenomenon. An international comparative study of burglary incidents confirmed that near repeat victimizations were ubiquitously identified within the different social contexts of several countries (Johnson et al., 2007a). Furthermore, while near repeat research typically analyzed residential burglaries, near repeats were also found for different crime types, including auto thefts (Johnson et al., 2009), shootings (Ratcliffe & Rengert, 2008; Wellset al., 2011), and insurgent activities in Iraq (Townsley et al., 2008). Youstin and her colleagues (2011), in particular, assessed the generalizability of near repeats by examining shooting, robbery, and auto theft in the same city. Although the spatial and temporal ranges of elevated subsequent crime risks varied by crime types, their study confirmed the presence of near repeats across these different types.

Scholars have proposed two theoretical explanations for repeat and near repeat victimizations: the risk heterogeneity hypothesis and the event dependency hypothesis (Farrell et al., 1995; Johnson, 2008). The risk heterogeneity hypothesis (also known as the flag hypothesis) suggests that victimization risks vary by place characteristics (e.g., types of housing), such vulnerabilities act as flags attracting potential offenders, and, subsequently, repeat incidents occur around these vulnerable locations. Therefore, the key variable under this hypothesis is varying vulnerabilities, and the offender of subsequent victimization incidents does not have to be the same person as for the initial incident. The hypothesis assumes that individual offenders' independent rational decision making about

criminal activities may produce a series of victimization incidents at or around places with higher vulnerabilities and more criminal opportunities. Several empirical studies have supported the risk heterogeneity hypothesis and found that varying victimization risks were generated through complex interactions of individual and neighborhood characteristics (Osborn & Tseloni, 1998; Tseloni, 2006; Tseloni & Pease, 2005). However, while the risk heterogeneity hypothesis can explain the spatial concentration of crime incidents at vulnerable locations, the hypothesis cannot adequately explain why the risk of subsequent victimizations changes dramatically over time, which is a key and consistent finding of repeat and near repeat victimization studies.

The event dependency hypothesis (also known as the boost hypothesis), on the other hand, proposes that subsequent victimization risks are temporarily increased (boosted) because of an initial victimization. An assumption of this hypothesis is that the same culprit (or an offender belonging to the same criminal network) is responsible for subsequent and repeat victimizations. Under the assumption of rational offenders, such practical knowledge as the locations of valuable items, the lifestyles of residents, and techniques of disarming security devices, are critical for the successful commission of crimes. Furthermore, repeating the same tasks that were previously successful requires less effort by the offender; that is, prior successful experiences of criminal activities are likely to reinforce the offender's future behavior and to increase his/her likelihood of targeting the same victims. Because neighborhood residents are likely to be of the same socio-economic status, share similar lifestyles and live in similar houses, the offender may also target these similar victims around the offender's prior targets, and this leads to near repeat victimizations.

There are several interview and survey studies of arrested offenders that support the event dependency hypothesis (Ashton et al., 1998; Everson & Pease, 2001; Kleemans, 2001; Shaw & Johnson, 2000). These studies indicated that 30 to 70% of the thieves and burglars had gone back to their prior targets; such a tendency was particularly pronounced among professional thieves with higher criminal tendencies. An analysis of reasons for going back to prior targets clearly reflected the rational decision making of the offenders, including a perceived lower risk of apprehension, the knowledge of house layouts, and the ease of access. Some offenders even indicated that they had gone back to their prior targets in order to steal items that they could not take previously.

In addition to these qualitative studies, there are also quantitative studies in support of the event dependency hypothesis (Bernasco, 2008; Johnson et al., 2009). An analysis of arrested offender data in England indicated that 99% of the repeat victimizations at the same addresses that occurred within two weeks of the initial victimization were committed by the same offenders, and 76% of the near repeat victimizations within 100 meters of the initial crime incident location were committed by the same offenders (Johnson et al., 2009). A similar pattern was also observed in a study in the Netherlands (Bernasco, 2008). Consistent evidence from these empirical studies in different cities indicates that near repeat victimizations are likely to occur because of the act of the same offenders. Additionally, Johnson (2008) comparatively evaluated the risk heterogeneity hypothesis and event dependency hypothesis using multi-agent simulation modeling. His study found that the simulation model under the event dependency hypothesis fitted observed data better than the risk heterogeneity model if each hypothesis was used independently, although the best fit was achieved when the two hypotheses were combined. Furthermore, a recent study that employed risk terrain modeling (RTM)

confirmed the predictive utility of combining both hypotheses in analyzing near repeat patterns (Moretoet al., 2014). Thus, these empirical findings suggest that victimization risks are unevenly distributed across space, and victimization risks are also dynamically influenced by actual crime victimizations.

The space-time clustering of crime incidents has typically been analyzed by innovatively incorporating an analytical technique developed in epidemiology. In particular, Knox's approach (1964) that was originally developed to examine the nature of the spread of childhood leukemia has been widely used in near repeat studies (Bowerset al., 2004; Johnson et al., 2007a; Johnson & Bowers, 2004a, 2004b; Townsley et al., 2003). Knox's epidemiological research proposed a statistical technique that examined spatial and temporal distances between the occurrences of each leukemia incident based on both the children's home locations and disease occurrence dates. By creating pairs of incidents and tabulating a contingency table that showed the frequency of pairs within given spatial and temporal intervals, the observed pattern was compared against a Poisson distribution for statistical significance. Knox's approach has been incorporated into geospatial crime analysis software *Crimestat* (Levine, 2004) and this software has been used in several near repeat studies (Bowerset al., 2004; Johnson & Bowers, 2004a; Townsley et al., 2003).

While Knox's approach is relatively simple in detecting space-time clustering through a contingency table, the approach potentially violates the assumption of independently distributed observations in a statistical hypothesis test, as Knox's approach compares pairs of incidents and each incident contributes to $n-1$ pairs in the analysis (Johnson et al., 2007a; Ratcliffe & Rengert, 2008). In order to overcome the problem, some researchers applied a Monte Carlo simulation approach in the significance test of the Knox's contingency table (Besag & Diggle, 1977; Johnson et al., 2007a). This approach conducts a statistical test of spatio-temporal clustering of events (e.g., crimes) by randomizing observations and generating a sampling distribution under the assumption that each event has occurred independently. The Monte Carlo simulation approach has been incorporated into Ratcliffe's near repeat calculator (2008) for crime analysis and is available to the public.

While these analytical software programs such as *Crimestat* (2004) and Ratcliffe's near repeat calculator (2008) are useful in crime analysis, they only allow a spatio-temporal analysis of the same crime type. For example, using these software programs and burglary incident data, crime analysts can examine the probability of subsequent burglary incidents for a given time period and identify the spatial and temporal extent of the elevated risk of near repeats from data. Ease of use of these software programs is particularly important for practitioners to identify local crime patterns in their jurisdictions, as the extent of elevated risks is likely to vary across jurisdictions. However, these existing software programs cannot simply be applied to the spatio-temporal analysis of multiple crime types, such as reports of contacts with suspicious persons and subsequent sex crime incidents, which is a focus of this research paper. In order to examine the spatio-temporal interactions of multiple crime types, the existing approach of detecting spatio-temporal interactions of single-type events needs to be extended.

Purpose of the study

Currently, Japanese law enforcement agencies treat the prevention of crimes targeting women and children as one of the most pressing safety matters, and they assume that reports of contacts with suspicious persons are precursor events of more serious sex crimes. As a result, the authorities implement a proactive policing strategy based on suspicious person reports and issue e-mail warnings of danger to parents, school administrators and neighborhood residents. However, extant research has not empirically confirmed the nature of spatio-temporal relationships between suspicious person reports and subsequent sex crime incidents. Thus, this paper examines if reports of contacts with suspicious persons are really precursor events of sex crimes by analyzing their spatial and temporal occurrence patterns. The ultimate objective of this research is to validate the current police practice and a widely held belief among the public that encounters with suspicious persons in a neighborhood raise the risk of future sex crimes in the area. Furthermore, if suspicious person reports can indeed be considered as precursor events of sex crimes, this research will also attempt to estimate the spatial and temporal extents that exhibit a significantly high risk of subsequent sex crime incidents in order to allow the police to allocate resources more effectively in focused policing. In the process of achieving this objective, this research will also contribute to criminological research methodologically by extending an existing space-time clustering analysis to a bivariate dimension with multiple crime types (i.e., suspicious person incidents and sex crimes). The proposed method can be easily extended to a spatio-temporal analysis of other crime types by future researchers (e.g., thefts from vehicles and vehicle thefts; attempted thefts and completed thefts).

Analytical strategy

The following procedures guided the empirical analysis of space-time clustering of suspicious person incidents and subsequent sex crimes with a Monte Carlo simulation approach. First, from incident-level data with date and time information, pairs of suspicious person contact reports and sex crimes were created. Second, differences in dates of occurrences and spatial distances between incident locations were calculated for each pair. Third, for those pairs where the encounters with suspicious persons occurred prior to the occurrence of sex crimes, a contingency table of event pairs was created using a set of spatial and temporal distance thresholds specified by the researcher.

After creating a contingency table of observed spatial-temporal interactions, the fourth step was to simulate a sampling distribution under the assumption that suspicious person reports and sex crimes occurred independently. In particular, dates of occurrences were randomized for both event types while fixing the occurrence locations (Besag & Diggle, 1977; Hope, 1968). The benefit of this randomization was that it controlled for underlying spatial and temporal patterns that crimes were more likely to occur in certain areas and at certain times, possibly due to different populations and risk factors. By repeating the randomized simulation for a given number of times (e.g., 999 times), a sampling distribution of spatio-temporal proximities of events could be generated. Finally, the observed patterns were then compared with the simulated distribution to examine if the observed data exhibited more pairs of events that occurred close in time and space than would be expected under a random distribution. The simulation program was created using statistical software *Stata*.

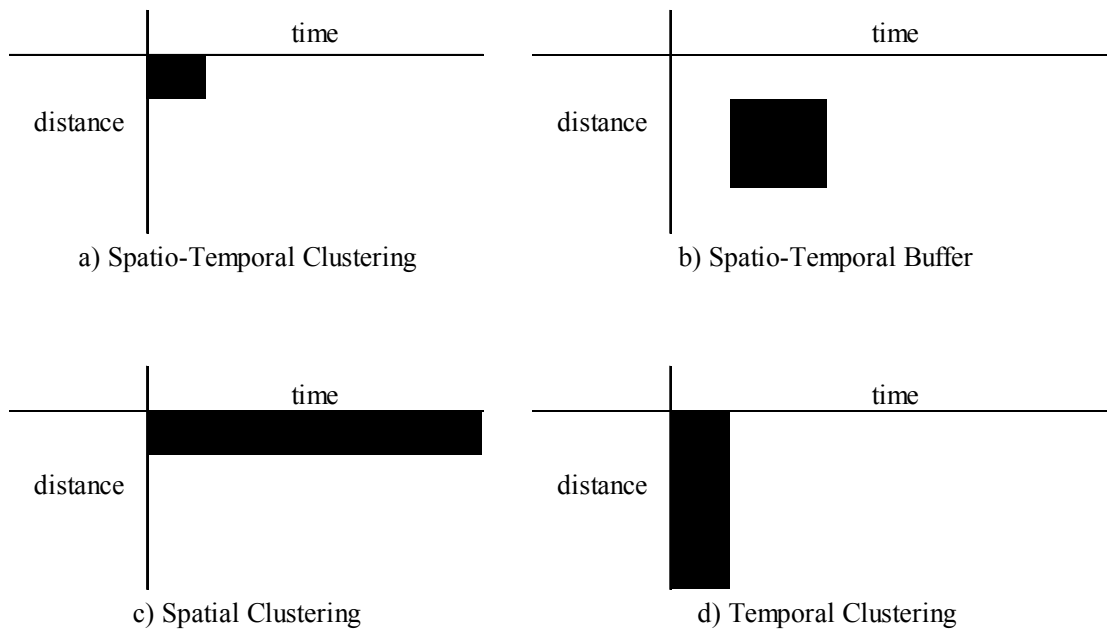
The benefit of the above approach is that, in addition to confirming the presence of overall spatio-temporal clustering, specific spatial and temporal extents of elevated risks can

be identified, which has practical implications for police resource allocation. However, its known limitation is that spatial and temporal thresholds of the contingency table need to be arbitrarily set. Ideally, the thresholds are guided by theoretical understanding of criminal behavior, existing studies, practical implications, and empirical distributions of crime incidents in a study area. Unfortunately, however, spatial studies of Japanese crime data are scarce. Thus, empirical distributions and practical implications of research findings were used to select 250 meters and one week as thresholds for the current study².

The overall pattern of the spatio-temporal relationship can be interpreted as shown in Figure 1. Suspicious person reports as precursor events of sex crimes will be confirmed if statistically significant cells are clustered in the top left corner of the table (Figure 1 a), where two events occur in closer proximity in both spatial and temporal domains than would be expected under a random distribution. The pattern depicted in Figure 1 b) implies that offenders wait for some time and change their hunting grounds after their initial behaviors as suspicious persons. If suspicious person incidents are viewed as attempted sexual crimes, offenders may avoid their previously unsuccessful locations and wait for some time in order to reduce their risk of apprehension and to increase their chance of success for subsequent attacks. In essence, unsuccessful criminal acts will modify the criminals' behavior templates, instead of reinforcing the same behavior (Brantingham & Brantingham, 2008). Thus, the pattern depicted in Figure 1 b) represents a spatial-temporal buffer, which invalidates the current police practice that allocates its resources immediately around suspicious person incidents for focused patrols. Nonetheless, the identification of such a pattern is still useful by specifying when and where a crime is likely to occur. This pattern can only be discovered by using a set of spatial and temporal thresholds, unlike Knox's original study that used a 2 by 2 contingency table of spatio-temporal proximities. In fact, a spatial-temporal buffer has been found in an existing study of robbery in the U.S. (Youstinet al., 2011). Sex criminals as foragers and predatory criminals may as well exhibit similar patterns. Finally, Figures 1 c) and d) reflect only spatial or temporal clustering but not both. Thus, both of these patterns will negate the idea of suspicious person reports as precursor events of future sex crimes.

² Because community organizations and police patrols in Japan are often based on a primary neighborhood as defined by the census, the area size of neighborhoods in the study area was analyzed. The median distance from the centroid to the edge of each neighborhood was about 300 meters. Furthermore, the average nearest neighbor analysis (Levine, 2004) of both suspicious person reports and sex crimes indicated that the observed mean distance between incidents was approximately 800 meters, which is a substantially longer distance than what is commonly found in studies in the U.S. and European nations. Moreover, given the low volume of crimes in Japan, short thresholds create many zeros in the Knox contingency table, which causes problems in statistical testing and the estimation of the Knox ratio. Thus, although the threshold of 250 meters was slightly longer than what had been used in existing studies in the U.S. and European nations, it was determined that this distance was suitable for the current study in the Japanese context. Examining spatio-temporal interactions by using varying spatial and temporal thresholds can become an extensive study itself (see Youstinet al. (2011), for example), and future studies may explore this issue in further detail.

Figure 1. A Guide to Interpret the Spatio-Temporal Proximity Contingency Table



Note: Blackened cells reflect statistically significant cells for illustration purposes. Modified from Townsley et al. (2003,p.623).

Data

This study examined the spatio-temporal relationship of suspicious person incidents and sex crimes by analyzing police report data of a large metropolitan prefectural police department in Japan for a period of three years. The jurisdiction of this prefectural police department includes a large metropolitan city, and the department’s volume of reported crime incidents ranks it as one of the top crime areas in Japan.

The first dataset is suspicious person reports, for which the nature of incidents widely varies, and the second is sex crimes that include sexual assaults and rape under the Japanese Penal Code. There is no uniform definition of suspicious person incidents across Japanese police jurisdictions. As an analysis of precursor events of sex crimes, this study did not include such incidents as a simple observation of a suspicious person in a street without any interactions with victims. Thus, the study data were limited to the incidents that involved some form of verbal or physical interactions between the offender and children/women (the victim/target). Some examples of suspicious person incidents included luring and tricking children with verbal communications such as “I will give you candy if you come with me”, while others included verbal communications with sexual connotations (e.g., “Let me buy your underwear”) and taking photos. Furthermore, other incidents included stalking and actual physical contacts such as suddenly grabbing bags and arms.

Both datasets had address fields and the date of occurrence fields which were used for spatio-temporal analysis. In particular, the address fields were geo-coded using GIS software as part of data preparation. Geo-coding is a process of assigning a longitude and latitude coordinate for each incident based on address information stored as a text. Of the

1,929 suspicious person incidents reported to the police during the three-year study period, this study used 1,396 incidents that could be geo-coded with sufficient accuracy³. Similarly, of the 669 sex crime incidents reported to the police, the geo-coding process produced 599 sex crime incidents that could be analyzed spatially and temporally.

Thus, the final study datasets included 1,396 suspicious person reports and 599 sex crime incidents with geographic coordinates, date of occurrence, and victim/target age characteristics.

Because the current police policies emphasize younger targets of suspicious person incidents as a precursor event, this study in particular divided both datasets into two based on age groups: elementary school age or younger (11 years old or younger) and older (12 years old or older). The decision to create these two groups were also made by taking into account the fact that many community functions and neighborhood watch activities are organized by school districts in Japan. Table 1 summarizes the target/victim characteristics.

Table 1. Victim Age Characteristics of Suspicious Person Reports and Sex Crime Incidents

<i>Suspicious Person Reports</i>	<u>Freq.</u>	<u>%</u>
Elementary School or Younger	835	59.8%
Junior High School	380	27.2%
High School	181	13.0%
Total	1396	

<i>Sex Crimes</i>	<u>Freq.</u>	<u>%</u>
Elementary School or Younger	117	8.4%
Junior High School	92	6.6%
High School	328	23.5%
Adult and Others	62	4.4%
Total	599	

³ Japanese geocoding is based on a series of areas starting from a prefecture (*ken*), a city (*shi*), a primary neighborhood (*cho*), a secondary neighborhood (*ban*), and a parcel (*go*). If GIS software cannot match the address of a crime incident stored as a text in an incident database with spatial data at the most detailed level (*go*), the software attempts to match the address at the next level until it finds the best match. The secondary neighborhood, *ban*, is roughly equivalent to an area surrounded by a block of streets in the U.S., while the primary neighborhood, *cho*, is the smallest census geographical unit in Japan and is roughly equivalent to census block groups in the U.S. Because the current study required distance calculations with a relatively high precision, it limited data to those matched at the secondary neighborhood level or better. As a result, the geocoding rate of the current study might be lower than that of prior studies in the U.S. and European nations. Nonetheless, a supplementary analysis did not find any particular areas from which suspicious person reports were overly removed because this study limited the geocoding precision at the secondary neighborhood level. Readers are referred to Harada and Shimada (2006) for the impact of geocoding precision on crime analysis in the Japanese context.

Results

Table 2 shows the results of spatio-temporal analysis by the age group of targets/victims (999 runs of Monte Carlo simulations). The clustering of statistically significant cells in the top left corner of Table 2 a) indicates that the observed pattern of suspicious person incidents and sex crimes was not a function of a random process; instead, the significant clustering of these two events in a small spatial and temporal distance to each other supports the idea of suspicious person events as a precursor event of sex crimes. More specifically, the table indicates that sex crimes are statistically significantly more likely to occur within 14 days (2 weeks) and 250 meters of the occurrence of suspicious person incidents targeting junior high school age children or older. Table 2 b), on the other hand, shows that sex crimes were not likely to occur near suspicious person incidents targeting elementary school children or younger. This is an important discovery, as the Japanese police focus more on suspicious person incidents targeting younger victims. Furthermore, such results also indicate that the nature of incidents relating to suspicious persons needs to be examined closely, instead of treating everything equally criminogenic.

Table 2. Spatio-Temporal Analysis of Suspicious Person Reports and Sex Crimes

a) Junior High School Children or Older as Targets

		Day				
		0 to <7	7 to <14	14 to <21	21 to <28	28 to <35
Distance (meter)	0 to <250	7.15**	6.04*	3.08	0.00	0.00
	250 to <500	2.05	1.78	3.23	0.00	0.00
	500 to <750	0.67	2.71	0.00	1.50	0.72
	750 to <1000	1.08	0.00	0.58	2.34	0.56

b) Elementary School Children or Younger as Targets

c)

		Day				
		0 to <7	7 to <14	14 to <21	21 to <28	28 to <35
Distance (meter)	0 to <250	4.09	0.00	0.00	0.00	0.00
	250 to <500	4.54	0.00	3.37	1.58	1.85
	500 to <750	0.00	2.01	2.17	0.00	0.00
	750 to <1000	0.00	0.00	1.68	0.00	0.00

Note: * $p < 0.05$; ** $p < 0.01$. Numbers represent the Knox ratios of the observed pair count to the mean pair count of the simulated distribution.

In addition to statistical significance, the substantive significance or effect size of the results was assessed by examining the ratio of the observed frequency of pairs to the mean pair count of the simulated distribution. The ratios, called the Knox ratio (Johnson et al., 2007b), indicate the substantive magnitude of spatio-temporal clustering, and quantify how likely sex crimes are to occur around suspicious person incidents for given spatial and temporal distances. For example, in the top left corner (less than 7 days and 250 meters) of

Table 2 a) for junior high school age children or older, the Knox ratio is 7.15, which means that sex crimes are 7.15 times more likely to occur around suspicious person incidents than would be expected under the assumption of a random relationship between the two events. The Knox ratios can be interpreted in a similar fashion for other cells; the overall pattern is that the value of the Knox ratios tends to decrease as spatial and temporal distances increase from the location and date of suspicious person incidents. That is, the likelihood of subsequent sex crimes decreases as the spatial distance increases and time passes from previous suspicious person incidents; this is another piece of evidence supporting the idea of suspicious person incidents targeting junior high school age children or older as a precursor event of future sex crimes.

Discussion and Conclusion

This study examined spatio-temporal relationships of suspicious person reports and sex crimes using Monte Carlo spatio-temporal simulations. By treating suspicious person incidents as precursor events of sex crimes, Japanese police agencies have warned the public and have intensified patrol activities, despite lack of empirical evidence supporting the validity of such practices. Thus, the current study aimed at statistically analyzing empirical data to scrutinize the idea of precursor events that elevate the likelihood of more serious crimes in the future. In particular, the study proposed an extension of Monte Carlo simulation models that have been used in existing studies to examine spatio-temporal relationship of two incident types.

The results indicated that suspicious person reports could be treated as precursor events of sex crimes. In particular, in the wake of encounters with suspicious persons, the risk of subsequent sex crimes was temporally elevated for 14 days within 250 meters around the encounter locations. Furthermore, the likelihood of sex crimes was considerably higher in areas closer to prior suspicious person incidents, and it decreased as the distance increased and time passed from the suspicious person incidents.

However, it is important to point out that the conclusion of suspicious person reports as precursor events of sex crimes was supported only for the incidents involving junior high school children or older, although the police seem to focus more on younger targets. Hence, it is more precise to conclude that this study has provided partial support of the current police practices that warn the public and that intensify patrol activities based on the occurrence of suspicious person incidents. It is reasonable to allocate limited police resources around prior suspicious person reports targeting junior high school children or older in order to effectively prevent sex crimes for a limited time. Warning the public around specific neighborhoods and locations for a limited time will make the warning announcement more realistic than constantly sending generic warning messages. The public is likely to pay attention to messages and announcements with more specific contents than general contents.

Immediate practical implications of the current study are evident in focused policing, geographic profiling, and efficient use of police resources. It is important to note, however, that the criminogenic nature of encounters with suspicious persons varied by incident characteristics, and policing should take into account these factors. Nonetheless, the results of the current study can help the development and implementation of data-driven, predictive policing. Systems of crime prediction models have already been developed in several countries and include *ProMap* which incorporates near repeat

mechanisms and has produced promising results (Bowers et al., 2004; Johnson et al., 2007b; Johnson & Bowers, 2004b). The research finding of this paper that identified suspicious person reports as precursor events of sex crimes with specific spatio-temporal ranges of elevated risks may also be incorporated in a future application development for predictive policing.

Despite such a strong practical implication of the current study, the use of reported crime data rather than offender data only allows for speculation on the theoretical mechanisms that generate the spatio-temporal interactions of the two events. Prior near repeat studies have suggested the risk heterogeneity hypothesis and event dependency hypothesis as theoretical explanations of near repeats. Empirical studies, in particular, have provided stronger support for the event dependency hypothesis in which the same criminal is assumed to be responsible for both the triggering and subsequent events based on the temporally changing risk pattern of subsequent events. As for suspicious person reports and sex crimes examined in this paper, if the two event types were repeatedly occurring in select areas without any temporal relationships between the two, the risk heterogeneity hypothesis that heavily weights place and area characteristics might be applicable in this context. However, similar to existing near repeat studies, this study found that the risk of future sex crimes decreased as time passed from suspicious person reports, which is more consistent with the event dependency hypothesis. It is cautioned that such a conclusion is only based on statistical analysis of spatio-temporal occurrence patterns, and the analysis was not able to incorporate offender information.

Future studies should consider a qualitative approach to further examine the nature of the relationship between suspicious person incidents and subsequent sex crimes. Interviewing arrested offenders may provide in-depth understanding of such a relationship and may confirm if the same offender is responsible for both incidents. Future studies with a quantitative approach may further examine different incident characteristics. Some existing near repeat studies, for example, have examined whether near repeat incidents are similar in occurrence time and modus operandi (Bowers & Johnson, 2004; Sagovsky & Johnson, 2007). This paper analyzed the spatio-temporal interactions of suspicious person reports and sex crimes by the target's age groups and found distinctive patterns. It is recommended that future studies examine additional characteristics, such as incident characteristics (e.g., incidents with verbal interaction only and incidents with physical contact) and occurrence time. Neighborhood characteristics may also play a role with certain areas exhibiting a higher likelihood of generating precursor and subsequent events, as has been reported in Bowers and Johnson's (2005) study of near repeat burglaries and socio-economic characteristics of neighborhoods. Moreto and his colleagues' study (2014) also confirmed the predictive utility of area characteristics in near repeat research. Such a detailed analysis with attention to qualitative characteristics of incidents and contextual characteristics will not only refine the precision of statistical analysis but also improve the predictive accuracy of future sex crimes. Warnings for the general public can also become more specific via such an approach.

An analysis of place characteristics can be particularly useful to deepen the understanding of criminal behavior. Although suspicious person encounters can be seen as an attempted (failed) offense, this paper found that sex crimes as a more serious offense are still likely to occur in the same area. That is, if one assumes that the same offender is responsible for both suspicious person reports and sex crimes, the offender as a forager is still likely to hunt for subsequent targets in the same area soon. This is an interesting

contrast to the pattern of robbery with a spatial buffer of near repeats that Youstin et al. (2011) observed. In particular, those researchers found a significantly heightened robbery risk in an area from two to five blocks from the original robbery incident, but not within a one-block area. Although both sex crime and robbery are predatory crimes, and both offenders forage suitable targets through rational decision making, their target selection may vary. Perhaps, place characteristics may play a more significant role in sex offenders' target selection as they are more likely to stick to the same area than robbers. Needless to say, different patterns can certainly arise because of different social contexts in Japan and the U.S. Future studies in Japan can benefit by examining a variety of offense types in multiple cities, which will strengthen the generalizability of spatio-temporal interaction patterns.

Future researchers might also attempt to replicate an empirical study of spatial-temporal clustering of crime incidents in the developing world by applying the approach proposed by the current study, in order to further scrutinize the idea of near repeats as a universal phenomenon. Most of the near repeat studies have been conducted in the U.S. and U.K., and their authors have claimed that near repeats of crime incidents are a universal phenomenon that exists across countries and across crime types (Johnson et al., 2007a; Johnson et al., 2009; Ratcliffe & Rengert, 2008; Wellset et al., 2011). The current study examined Japanese data to see if the spatio-temporal clustering of crime incidents exists in a low crime nation in Asia, and provided statistical evidence of spatio-temporal clustering. More studies that test the idea of near repeats as a universal phenomenon by examining crime data from developing nations will be most certainly welcomed and will be an important contribution to the body of criminological knowledge. In such an endeavor, the following data issues may become important considerations in order to conduct a valid and reliable study. First, it is important to develop and utilize a centralized database that stores crime and related information. In a study like the current one where crime incidents and suspicious person reports are examined, different government entities may be responsible for collecting the information for each event type. However, a single, centralized database will be important not only to conduct a scientific study that estimates the extent of heightened risks in space and time, but also to implement focused policing strategies based on the study's results. Unless the information is centrally collected and stored, guiding police resources based on analysis results in near real time cannot be accomplished. Second, it is important to standardize data collection and recording methods. Of particular relevance will be address and time information. Address information needs to be geo-coded to longitude and latitude coordinates using Geographic Information Systems (GIS). Although geo-coding methods vary from country to country (e.g., a street segment system like in the U.S. and an area-based geo-coding scheme like in Japan), what is crucial in any methods is to record address information as accurately and consistently as possible. Furthermore, temporal information also needs to be recorded consistently. For example, some may record occurrence dates, while others may record reporting dates only. Moreover, one may record dates only, while the other also records times. Occurrence dates and times may be difficult to record depending on circumstances and victims' recollections; however, it is nonetheless important to create a database that records information in a consistent fashion. Third, governmental efforts to encourage victims to report incidents to authorities will also be an important consideration to strengthen the validity and reliability of any study. This will be especially the case

where a less serious incident like the current study focused on becomes the topic of future studies, as minor incidents generally suffer from a low reporting rate.

Moreover, regarding future studies, it may also be of importance to attempt to extend a spatio-temporal study to cyber crimes. The current study's focus was predatory crimes occurring in the physical world; however, as traditional criminological theories such as routine activities theory may be applicable to crimes in the cyber world (Grabosky, 2001; Holt & Bossler, 2007; Reyns et al., 2011), an analysis of spatio-temporal proximity of incidents may also be attempted in cyber-crimes. First, researchers may focus on a temporal domain in examining precursor events in the cyber world, as a physical distance may be of less importance in cyberspace. Then, virtual interactions between victims and perpetrators may be examined both qualitatively and quantitatively. A qualitative exploration may break down the interactions into stages in order to identify precursor events or keywords that lead to criminal events (e.g., taking nude photos or escalated bullying). A script analysis (Cornish, 1996) to study crime events that identify different stages of criminal behaviors may be followed in such a study. A quantitative study, then, further examines how the precursor words and crime incidents are temporally close to each other to statistically assess heightened victimization risks. Second, for those offenses that start with virtual encounters but ultimately end with predatory crimes in person, proximity in both spatial and temporal domains may be examined by applying the analytical approach proposed in the current study. Of particular relevance in this regard may be space transition theory (Jaishankar, 2008 cited in Jaishankar, 2007) which postulates that people including offenders behave differently in the cyber world and in the physical world. Spatio-temporal proximity of precursor events in cyberspace may be examined by using digital footprints of Internet interaction times and IP addresses as well as the time and location of actual encounters in the real world. Thus, in theory, the analytical approach proposed in the current study may also be applicable to cyber-crimes, especially those that end in predatory crimes in the physical world. As Pittaro (2007) noted, it is quite possible that cyber-crimes may not be as predictive as traditional crimes, especially in the context of cyber stalking that he examined. It remains as an empirical question whether spatial-temporal clustering may be detected for cyber-crimes, and future studies may examine this using empirical data.

As with any empirical studies, the current study is not free of limitations. Most notably, there is a problem of unreported incidents (the dark figure). The dark figure may be particularly problematic in the analysis of sex crimes that tend to have a low reporting rate. While one may argue that the official police reports lack validity, there are reasonable justifications to use them for the current research question. First, although victimization surveys may be suggested to overcome the problem of the dark figure, a survey that samples just a small fraction of residents in the study area will still not capture all crime incidents with precise location and occurrence time information. Because the current study requires spatial and temporal information with sufficient accuracy for a micro-level statistical analysis as with any near repeat studies, victimization surveys that rely on the victims' memory are not likely to produce such precise data. Second, the current study aims at proposing a research methodology and identifying empirical research findings that have practical implications for everyday police practice. Hence, it was actually preferable to utilize types of data that the police routinely collect. Using the police data was an ideal way to scrutinize the validity of the current patrolling practice that assumes that suspicious person reports are a precursor event of more serious incidents. Nonetheless, future studies

may conduct victimization surveys and investigate if reporting rates are higher/lower in certain areas.

Second, this study used age as a discreet category by school age. Such analysis was conducted because community functions and neighborhood watches in Japan are organized by school districts, and because the Japanese police have focused particularly on incidents targeting elementary school children. Future studies may examine age as a continuous variable, although an analysis of spatio-temporal interactions of point patterns with continuous marks can be highly complex.

Third, a relatively low geo-coding rate was a potential concern, and the geo-coding rate should ideally be higher. The geo-coding rate became low because this study required spatial information at a fine scale in order to precisely calculate spatial distances. However, a supplementary analysis did not find any particular areas from which suspicious person reports were overly removed due to lack of precise address information. Thus, the general spatial distribution of suspicious person reports remained the same for the entire data and those used in the current paper. Furthermore, instead of including all cases matched at a less-fine scale, removing these incidents with less-precise address information was actually preferable for the current analysis. Those cases geo-coded at the centroid of a higher aggregation level of areas (wider areas) would have created artificial spatial clustering of incidents. Thus, the current study could be interpreted as a conservative estimate of spatio-temporal clustering.

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