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Understanding and Controlling Hot Spots of Crime: The Importance of Formal and Informal Social Controls

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Abstract Primary, secondary, and tertiary prevention programs that address opportunity or structural factors related to crime are usually delivered to entire cities, sections of cities or to specific neighborhoods, but our results indicate geographically targeting these programs to specific street segments may increase their efficacy. We link crime incidents to over 24,000 street segments (the two block faces on a street between two intersections) over a 16-year period, and identify distinct developmental patterns of crime at street segments using group-based trajectory analysis. One of these patterns, which we term chronic crime hot spots, includes just 1 % of street segments but is associated with 23 % of crime in the city during the study period. We then employ multinomial regression to identify the specific risk and protective factors that are associated with these crime hot spots. We find that both situational opportunities and social characteristics of places strongly distinguish chronic crime hot spots from areas with little crime. Our findings support recent efforts to decrease crime opportunities at crime hot spots through programs like hot spots policing, but they also suggest that social interventions directed at crime hot spots will be important if we are to do something about crime problems in the long run. We argue in concluding that micro level programs which focus crime prevention efforts on specific street segments have the potential to be less costly and more effective than those targeted at larger areas such as communities or neighborhoods.

Keywords Crime prevention · Street segments · Social control · Opportunity · Hot spots

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Introduction

It has long been argued that the best way to deal with the crime problem is to focus on criminogenic traits of individuals or large social units like neighborhoods (Clarke and Felson 1993; Weisburd 2002). Recent research suggests that there is another approach to the crime problem that has strong potential both for understanding and doing something about crime. That approach capitalizes on the fact that crime in cities is concentrated at a relatively small number of places. Prior research has shown that fewer than 5 % of street addresses in a city produce half of all emergency calls to the police (Pierce et al. 1986; Sherman et al. 1989). A similar proportion of street segments (both block faces between intersections) have been found to produce 50 % of all crime incidents over 14 years (Weisburd et al. 2004).

The potential of such geographic concentration of crime for policing has been recognized since the 1990s. A randomized field trial in Minneapolis showed that the concentration of police patrol at hot spots of crime led to reductions in offending levels (Sherman and Weisburd 1995). Replications of the Minneapolis experiment, focusing on different types of crimes and police interventions generally confirm the original study, adding evidence that police interventions focusing on crime hot spots are not likely to lead to displacement of crime nearby (see Braga and Weisburd 2010).

This led the National Research Council Committee to Review Research on Police Policy and Practices to conclude that "studies that focused police resources on crime hot spots provide the strongest collective evidence of police effectiveness that is now available" (2004: 250).

The hot spots policing approach has been based primarily on theoretical perspectives that emphasize the immediate situational opportunities presented by particular places. These theoretical perspectives are often termed "opportunity theories" (see Cullen 2010; Wilcox et al. 2003). Routine activities theory (Cohen and Felson 1979), situational prevention (Clarke 1995), and crime pattern theory (Brantingham and Brantingham 1993) all place great emphasis on the specific opportunities offered by specific places and situations. In this context, the Minneapolis Hot Spots Experiment (Sherman and Weisburd 1995) sought to increase the formal guardianship of the police at hot spots in order to reduce the situational opportunities for crime. Durlauf and Nagin (2011) argue that the key to such strategies is that they deter offenders from taking advantage of crime opportunities by increasing the perceived risk of apprehension at high crime places. But is deterrence through policing the only approach that should be used to ameliorate crime hot spots?

Study of crime at higher geographic levels has placed emphasis on the social characteristics of places, emphasizing what is often termed "social disorganization" (see Sampson and Groves 1989; Shaw and McKay 1942). Social disorganization theories suggest responses to the crime problem that are focused "on the effectiveness of informal mechanisms by which residents themselves achieve public order" (Sampson et al. 1997: 918). Sources of the differential ability of communities to regulate their residents are reflected in structural characteristics such as poverty and residential mobility, or the ability of neighborhoods to restrain unruly juveniles. Noting the importance of self-efficacy to individuals, Sampson et al. (1997: 919) coined the concept of collective efficacy of communities, or the "willingness [of residents] to intervene for the common good," to emphasize the mechanisms by which a community can prevent crime through enhanced informal rather than formal controls.

In our study, we seek to examine the contributions of both opportunity and social disorganization theories to our understanding of the risk and protective factors associated with hot spots of crime. In this we follow a number of scholars who have sought "theoretical integration" of opportunity and social disorganization theories at place, though their level of geographic analysis has been much higher than that which we propose (e.g. see Wikström et al. 2010; Wilcox et al. 2007). Of course, theoretical integration of opportunity and social disorganization theories in a model for understanding crime at micro levels of geography does not make sense if social disorganization is a concept that is irrelevant at that geographic level. This seems to be the position of many scholars in this area. Sherman et al. (1989: 30), for example, argue that "(t)raditional collectivity theories [termed here as social disorganization theories] may be appropriate for explaining community-level variation, but they seem inappropriate for small, publicly visible places with highly transient populations."

But the geographies of crime hot spots may also be seen in many cases as small-scale communities. For example, a number of hot spots studies (including our own, see below) use street segments or street blocks as a key unit for examining the distribution of crime. Taylor (1997, 1998) argues that such micro geographic units function as "behavior settings" (Wicker 1987: 614). They have many of the traits of communities that have been seen as crucial to social disorganization theory, in that these physical units function also as social units with specific routines.

This approach is reinforced if we examine the distribution of social disorganization characteristics in our data across the city. For example, we collected data on public housing and Section 8 vouchers at street segments in Seattle, finding that there are "public housing assistance hot spots." Indeed, 50.0 % of housing assistance is consistently found on approximately 0.4 % of the street segments in Seattle. There is also strong street-by-street variability, emphasizing the importance of hot spot segments rather than larger area concentrations. Within 800 feet of the public assistance hot spots, 84.3 % of street segments do not have any public housing assistance recipients.

The Study

We link crime incidents to over 24,000 street segments (the two block faces on a street between two intersections) over a 16-year period, and identify distinct developmental patterns of crime at street segments using group-based trajectory analysis. Our analysis identifies a chronic crime hot spot pattern that includes just 1 % of street segments but is associated with 23 % of crime in the city during the study period. We then link a series of measures reflecting opportunity and social disorganization theories to the street segments. Finally, we employ multinomial regression to identify the specific risk and protective factors that are associated with membership in the chronic crime hot spots pattern.

The Geographic Unit of Analysis

The geographic unit of analysis for this study is the street segment. Our study included 24,023 street segments in Seattle, Washington. The average length of a street segment in Seattle is 387 feet. The majority of the streets (roughly 64 %) are between 200 and 600 feet. As we noted above,

street segments can be seen as behavior settings. Moreover, street segments are easily recognized by residents and have well-defined boundaries. Operationally, the choice of street segments over smaller units such as addresses also minimizes the error likely to develop from miscoding of addresses in official data (see Klinger and Bridges 1997; Weisburd and Green 1994).

Crime Data

To identify crime trajectories of street segments, we used information on crime incidents from the Seattle Police Department over a 16-year period from 1989 to 2004. Incident reports are generated by police officers or detectives after an initial response to a request for police service. Our final sample included 1,697,212 crime records that were then joined to their corresponding street segments so that crime frequencies for each of the 24,023 segments for each year could be calculated.[1]

Identifying Chronic Crime Hot Spots

We applied group-based trajectory analysis (Nagin 2005; Nagin and Land 1993) to identify common patterns of crime at street segments over the 16-year observation period. Group-based trajectory analysis is designed to identify latent groups of individuals with similar developmental pathways and has been used in a number of studies of developmental patterns of individual criminality (Nagin and Odgers 2010), and more recently it has also been applied to crime places at different levels of geography (e.g., see Griffiths and Chavez 2004; Weisburd et al. 2004).

The Zero Inflated Poisson distribution provided the best fit to our data. In choosing the number of groups or trajectories we relied upon the Bayesian Information Criteria (BIC). In terms of the procedure used to identify the optimal model, we followed the exhaustive approach detailed in Nagin (2005). That is, we tested for all possible combinations of numbers of groups and polynomial order of each trajectory. After reviewing the BIC and the patterns observed in each solution, it was determined that a 22 group model was optimal for understanding the crime data at street segments. The validity of this solution was confirmed when we reviewed the posterior probabilities for the different trajectories. Nagin (2005) recommends that the posterior probabilities for specific trajectories be above 0.70. The majority of the within-group posterior probabilities in the model are above 0.90, and the lowest posterior probability is 0.77.

The trajectory analysis suggests the salience of the hot spots approach (see Fig. 1). While there are varying trajectories at different levels of crime (and reflecting different developmental patterns), what is striking in our analysis is a single trajectory group (Trajectory 21) that includes just 1 % of the street segments but accounts for fully 23 % of crime in the city.[2] Street segments in this group average between 80 and 110 crime incidents each year throughout the study period. We term these very high rate street segments "chronic crime hot spots" both because of their very high levels of crime and because they consistently evidence much higher rates of crime across the entire study period. In contrast, almost half of the street segments in the city may be classified as belonging to a "crime free pattern" in which there is little or no crime during the study period (see trajectories 2, 4, 5 and 6).

Do these chronic crime hot spots represent micro or macro geographic processes? The idea that crime has been clustered in communities has long been a part of our understanding of crime problems (Shaw and McKay 1942). But our data suggest that in addition to community influences, there are important local area processes that need to be taken into account. Figure 2 shows the chronic crime hot spots on a map of Seattle. There is tremendous spatial heterogeneity as evidenced by the spread of crime hot spots throughout the city. At the same time, there is a clustering in the central business area of the city. But even here, as the map inset shows, there is still significant street to street variability. Across the city, about 78 % of street segments within 800 feet of a chronic crime hot spot street segment were either crime free or evidenced low crime patterns.

Measurement and Hypotheses: Opportunities and Social Disorganization at Places

Identifying retrospective longitudinal data on crime opportunities and social disorganization at the street segment level represented a major challenge for our study. Unlike crime data which are routinely collected by police agencies, there is not a single repository for information on the key theoretical concerns we have raised at the street segment level. In turn, social data on geographic areas

[1] Intersections are excluded in our study in part because each intersection is attached to two or more street segments. In turn, incident reports at intersections differed dramatically from those at street segments. For example, traffic-related incidents accounted for only 3.77 % of reports at street segments, but for 45.3 % of reports at intersections. We also excluded the University of Washington campus from our analyses because crime data were not available for most of the study period.

[2] Trajectory group 1 also represents an interesting hot spot pattern, with its steeply rising trajectory over the time period. Nonetheless, this group includes only 0.2 % of the street segments in the study, and accounts for only 1.5 % of crime overall. For a comparison of increasing and decreasing trajectories, see Weisburd et al. (2012a).

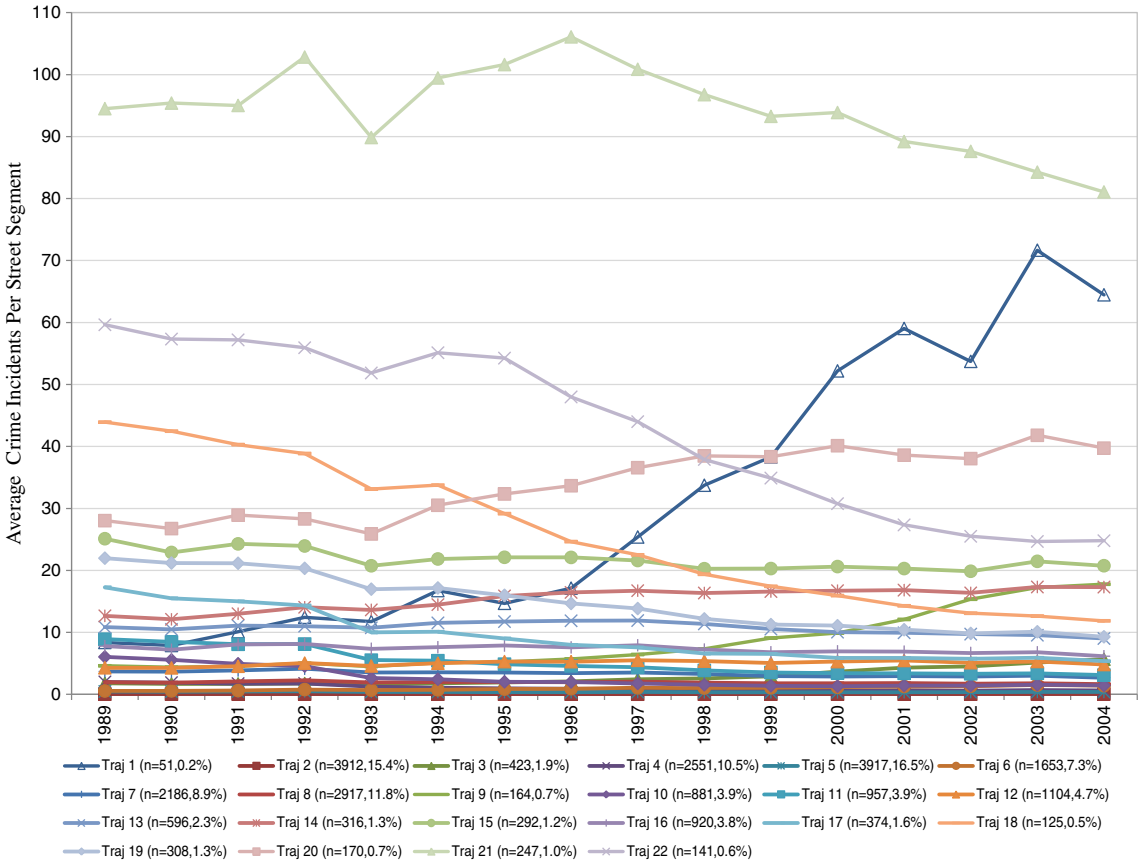

Fig. 1 Trajectory analysis for street segments (percentages refer to percentage of total street segments in that trajectory group)

are not released by the U.S. Census at the street segment level because of fears of identifying individuals and accordingly violating confidentiality.[3]

We examined many databases that are routinely collected in Seattle and code information geographically, and we were able to collect a wealth of data reflecting opportunities for crime and social disorganization at places using archival records. Though our data are the most exhaustive we are aware of for examining crime trends at the street segment level, in some cases we could not measure directly key dimensions of either opportunity or social disorganization, a limitation of our study we return to later. Table 1 lists the variables collected, the data sources, and their temporal coverage during the study period.

In opportunity theories of crime, motivated offenders are assumed to increase the risk of crime (Cohen and Felson 1979). A key indicator of motivated offenders is what we term high-risk juveniles (see Baumer et al. 1998; Bernasco and Nieuwbeerta 2005; Bursik and Grasmick 1993), measured in our study as the number of school students that live on a street segment who evidence truancy or poor academic achievement. We also identify a number of characteristics that reflect the opportunities for crime created by potential crime targets on a street segment. More employees are expected to increase the number of suitable targets (Brantingham and Brantingham 1995), as are larger numbers of residents (Felson 1986),[4] and more public facilities on or nearby a street segment that bring people to places (see Cromwell et al. 2008; Groff and McCord 2012; Roman 2002). Business activities (as represented by total retail sales) are also expected to attract people to street segments who then become suitable targets for crime (Beavon et al. 1994; Crewe 2001; Duffala 1976; LaVigne 1994).

[3] Moreover, we have found that there is tremendous street-by-street variation not only in crime, but also in risk and protective factors related to crime (Weisburd et al. 2012a) suggesting that data at higher level units like census blocks or census block groups would be inappropriate for our study.

[4] Because census data are not available at the street segment level, we used data describing registered voters and public school students to develop an estimate of the number of residents on each street. To assess this relationship, we aggregated up our street segment estimates to census block groups for the year 2000. We then estimated a correlation between our data and the census estimates. We found a highly significant correlation of 0.70, indicating that there is a degree of error in our measure, but that overall it fits fairly well to the actual population of areas in Seattle.

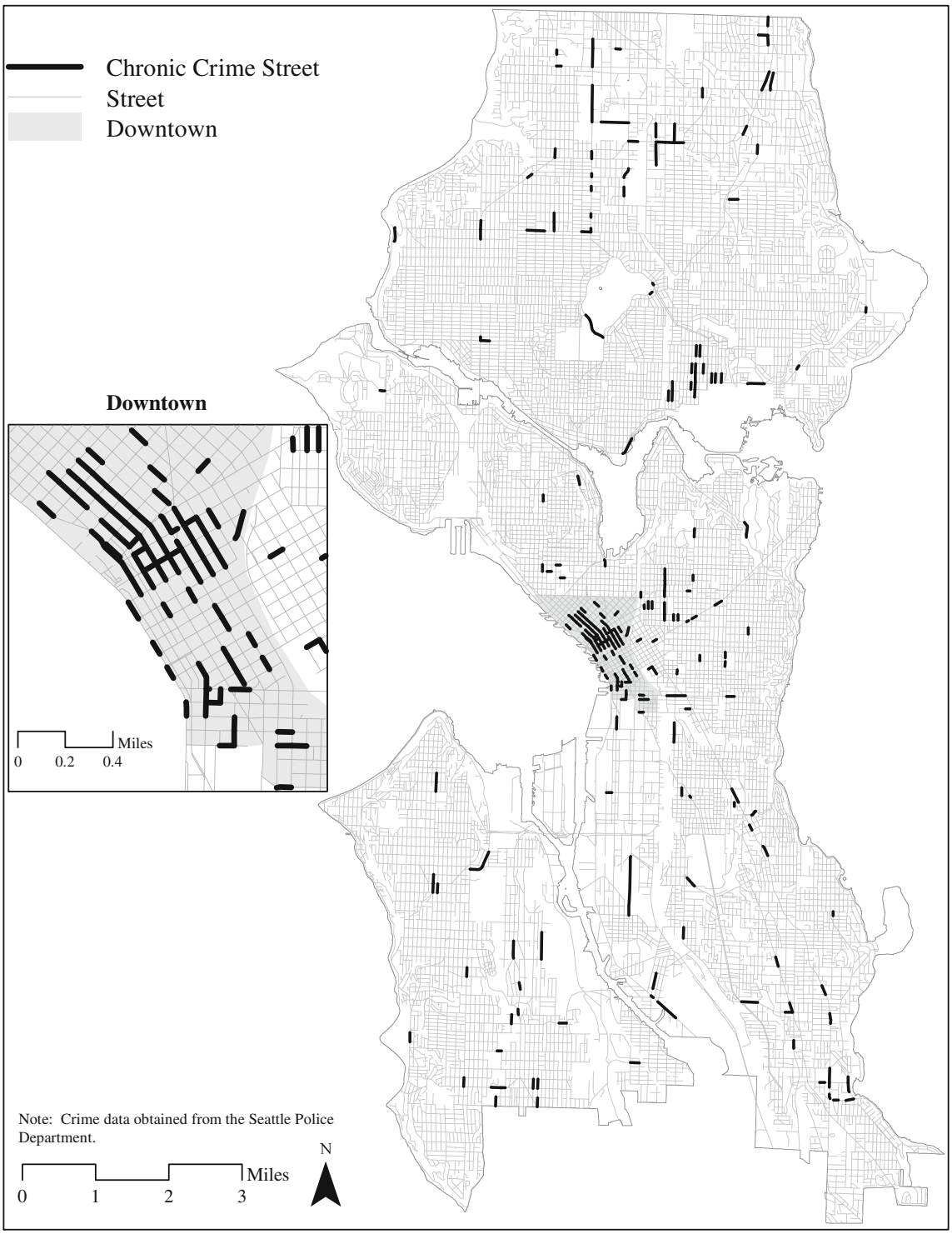

Fig. 2 Chronic hot spot street segments in Seattle

Urban planners and criminologists have long been interested in how accessibility and urban form more generally increase opportunities for crime (Jeffery 1971; Newman 1972). We use the number of bus stops on a street and whether the street is an arterial road, as measures of these risk factors. Easier access through bus transportation, or the presence of an arterial road, is expected to increase both the number of suitable targets on a street segment and the ease with which motivated offenders can access such targets, thus increasing the likelihood of crime events (Roman 2005; Wilcox et al. 2004).

Table 1 Description of the variables in the model

Variable name	Description (temporal span)	Data source
Opportunity		
High-risk juveniles	Total number of public school students who are truants or low academic achievers (92–04)	Seattle Public Schools
Employment	Total number of employees (98, 00, 02, 04)	InfoUSA business database
Public facilities	Total number of public facilities (community centers, parks, libraries, middle/high schools, hospitals) within one quarter mile (89–04)	Seattle Public Libraries, Fleets & Facilities Department, Yellow Pages, Seattle Public Schools
Residents	Total number of residents (sum of registered voters and public school students) (99–04)	Seattle Public Schools/Labels & Lists Inc.
Total retail sales	Total retail sales in dollars divided by 1,000 (98, 00, 02, 04)	InfoUSA business database
Bus stops	Total number of bus stops (97–04)	Metro Transit Division
Arterial road	Is the street segment an arterial road? (06)	Seattle GIS
Police/fire stations	Total number of police or fire stations within one quarter mile (1,320 ft) (89–04)	Fleets and Facilities Department
% vacant land	Percentage of vacant land (91, 93, 95, 97, 98, 04)	Historic Assessor's Data (Seattle Planning Department)/ parcel boundaries (King County GIS)
Street lighting	Total number of watts divided by 100 (97–04)	Seattle Public Utilities
Social disorganization		
Residential property values	Combination of weighted ranking of single family housing and multi-family housing of a given street (91, 93, 95, 97, 98, 04)	Historic Assessor's Data (Seattle Planning Department)/parcel boundaries (King County GIS)
Housing assistance	Combination of public housing and Section 8 vouchers (98–04)	Seattle Housing Authority
Mixed land use	Binary variable, indicating whether street has a mixture of between 25 % and 75 % of residential and other land use types (91, 93, 95, 97, 98, 04)	Historic Assessor's Data (Seattle Planning Department)/ parcel boundaries (King County GIS)
Racial heterogeneity	Racial heterogeneity of public school students (92–04)	Seattle Public Schools
Urbanization	Distance of a street to the center of city divided by 100 ft (06)	Seattle GIS
Physical disorder	Number of physical disorder incidents (93–04)	Seattle Public Utilities
Truant juveniles	Number of public school students who are truants (92–04)	Seattle Public Schools
% active voters	Percentage of active voters out of all registered voters (99–04)	Labels & Lists Inc.
Other variables		
Segment length	Total number of feet (divided by 100)	Seattle GIS
Spatial lag	Average number of crimes on neighboring street segments within one quarter of a mile	Seattle Police Department

We could not identify any direct measures of formal guardianship at street segments. At the outset of our study we tried to gain a direct measure of police guardianship, but found it impossible to construct such a measure in an accurate way.[5] We were able to identify three indirect measures of guardianship: the presence of police or fire stations within a quarter of a mile of a street segment; the percent of vacant land on a street segment; and the extent of public lighting on the street segment. Proximity to formal guardianship such as police and fire stations is expected to act as a protective factor against crime, as is the presence of more street lighting at the street segment (Farrington and Welsh 2002). Vacant land is often associated with a lack of guardianship at places (Kurtz et al. 1998; Taylor et al. 1995).

As for social disorganization theory, the socioeconomic status of street segments was measured through residential property values, and the extent of housing assistance (see Table 1). If social disorganization theory is relevant at the street segment level, it would be expected that economic advantage would act as a protective factor against crime, and poverty as a risk factor for crime (Connolly et al. 2010; Kubrin and Weitzer 2003; Smargiassi et al. 2006). Theorists have assumed that poorer and more disadvantaged populations will have more difficulty in exercising informal social controls. Informal social controls, or social ties, are also expected to be weaker in places where there are more heterogeneous racial populations (Bursik and Grasmick

[5] We tried to use emergency crime call data, which lists the times when police are responding to calls as a way of tracking police presence, but we were able to gain data only for 4 years of our study period, and those data were extremely highly positively correlated with crime incident data. We concluded that the data overall reflected not police patrol at places, but police response to crimes at specific places, many of which were later identified as the locations of crime incidents.

1993; Kornhauser 1978; Sampson and Groves 1989), or where there is a mixture of residential and commercial land usage (Roncek 2000; Stark 1987). Where populations are heterogeneous (measured in our study in reference to the heterogeneity of students living on a street segment), or businesses intermingled with residential housing, theorists have assumed that people will less effectively be able to join together for collective activities, and accordingly will not be as able to marshal effective informal social controls. Urbanization, or distance from the city center, has long been considered a risk factor for crime in the social disorganization perspective because it is assumed that urban centers are more anonymous and less likely to facilitate community interaction (Thrasher 1927/[1963]). In turn, physical disorder (as reported by residents, inspectors, and other agencies to Seattle Public Utilities in our study) has been viewed as a broader indicator of the lack of social organization and informal social controls in communities (Perkins et al. 1990; Shaw and McKay 1942).[6]

Recent social disorganization theories also include mediating factors that link the structural factors (e.g. poverty, mobility) and crime (Bursik 1988; Sampson and Lauritsen 1993: 58). These mediating factors reflect more generally the degree to which people who live in communities can exercise social control over the behavior of residents and visitors (Coleman 1993). For example, unsupervised teens as a mediating factor was first conceptualized by Sampson and Groves (1989: 778), who argued that "communities that are unable to control street-corner teenage groups will experience higher rates of delinquency than those in which peer groups are held in check through collective social control." In this study, we are able to measure this construct using the number of truant juveniles on a block as indicated by public school data. However, it is important to note at the outset the strong overlap between our measurement of high-risk juveniles and our measure of truant juveniles.[7] We think that the two constructs are theoretically distinct, capturing different underlying causal processes, but nonetheless we recognize their strong colinearity and test for its possible impacts on our models (as noted in our discussion later).

Collective efficacy has come to be seen as an important representation of the ability of residents of communities to exercise social control (Sampson et al. 1997). One important indicator of collective efficacy is residents' willingness to participate in public affairs (Morenoff et al. 2001; Sampson et al. 1997). Voting behavior has been used by scholars at macro levels of geography to assess overall participation and normative involvement in communities (see also Coleman 2002; Putnam 2001). We use percentage of "active voters," defined as people who voted more than the population average in the two previous years, as a general indicator of the extent to which residents are willing to participate in public affairs. In Table 2 we report basic descriptive statistics for the main variables in the analysis for both the chronic crime hot spots pattern and the crime free pattern street segments.

Analytic Strategy

To identify risk and protective factors associated with crime hot spots we employ a multinomial logistic regression that predicts membership in trajectory patterns. We chose to examine general trajectory patterns rather than the 22 trajectory groups described in Fig. 1 both because of our desire to focus on basic relationships (rather than specific trajectories) and because recent criticisms of group-based trajectory models have argued that trajectory assignment is likely to be imprecise when there are small differences between groups (see Eggleston et al. 2004; Skardhamar 2010). We divided the initial trajectories into eight patterns based on a visual inspection of the level of crime over the time period and the overall direction of change (see Supplemental material). In our analysis, the crime free trajectory pattern is the reference group both because it includes the largest number of cases (11,898; maximizing the statistical stability of the overall model), and because it provides a logical comparison group for understanding the analysis. We report in Table 3 only the estimates comparing the chronic crime hot spots trajectory with the crime free pattern, but the overall multinomial regression from which these estimates are gained included all of the trajectory patterns (see Supplemental material for the full multinomial regression results).[8] For each measure in our study, we created a variable reflecting the "baseline" estimate, or the mean of the first 3 years for which we have valid data. We also include a measure of change over time, but only when we have valid data available for a long time series and there is evidence of statistically significant change at the street segment level. In addition, we control for the influence of crime occurring

[6] Physical disorder indicators include the number of incidents of illegal dumping, litter, graffiti, overgrown weeds, inoperable cars on the street, junk storage, exterior abatement, substandard housing, and minor property damage.

[7] The number of high-risk and truant juveniles on a street are strongly correlated (r=0.91), because both measures include truancy as a factor. Number of high-risk juveniles, however, also takes into account school performance.

[8] Using this approach rather than simply comparing the chronic and crime free patterns in an ordinary logistic regression we gain greater model stability and more accurate estimates of standard errors for the specific comparison.

Table 2 Descriptive statistics for independent variables for the crime free and chronic crime hot spots pattern

	Crime free pattern (N=11,898)				Chronic hot spots pattern (N=247)			
	Minimum	Maximum	Mean	Std. deviation	Minimum	Maximum	Mean	Std. deviation
Opportunity								
High-risk juveniles	0.00	11.00	0.11	0.44	0.00	93.33	3.18	10.22
Employees	0.00	447.51	1.05	9.59	0.00	7040.59	377.75	927.52
Public facilities	0.00	6.00	0.47	0.78	0.00	6.00	1.06	1.22
Residents	0.00	76.00	5.29	7.04	0.00	597.50	60.80	93.26
Total retail sales	0.00	159.16	0.11	2.51	0.00	1810.62	37.44	138.76
Bus stops	0.00	5.00	0.08	0.32	0.00	4.67	0.86	0.93
Arterial road	0.00	1.00	0.20	0.40	0.00	1.00	0.85	0.36
Police/fire station	0.00	2.00	0.05	0.22	0.00	2.00	0.23	0.47
% vacant land	0.00	1.00	0.02	0.11	0.00	1.00	0.03	0.13
Street lighting	0.00	102.50	2.11	3.73	0.00	225.17	20.33	22.52
Social disorganization								
Property value	0.00	10.00	4.25	3.86	0.00	10.00	1.75	2.92
Housing assistance	0.00	112.00	0.11	1.52	0.00	299.00	7.52	33.45
Mixed land use	0.00	1.00	0.04	0.20	0.00	1.00	0.04	0.21
Racial heterogeneity	0.00	0.17	0.00	0.02	0.00	0.17	0.03	0.05
Urbanization	2.93	572.03	270.89	110.94	24.36	457.69	188.39	140.59
Physical disorder	0.00	6.67	0.04	0.19	0.00	6.67	0.62	1.01
Truant juveniles	0.00	5.33	0.04	0.21	0.00	31.67	1.16	3.53
% active voters	0.00	1.00	0.36	0.37	0.00	1.00	0.17	0.21
Other variables								
Segment length	0.09	40.28	2.88	1.87	0.69	21.74	5.50	3.25
Spatial lag	0.00	60.90	3.79	3.71	0.77	58.76	17.23	15.11

on neighboring streets through the use of a spatial lag variable. We also include a measure of the length of the streets as a control variable. The pseudo R^2 values produced in our model are 0.63 (Cox and Snell) and 0.68 (Nagelkerke).

It is important to note at the outset that our models reflect the relationships between the opportunity and social disorganization measures that we examine and the developmental trajectories of crime that are observed and that causality is difficult to establish in our data as in other observational studies.

Results: Risk and Protective Factors Associated With Chronic Crime Hot Spots

Opportunities for Crime

Consistent with opportunity theories of crime, we find evidence of the importance of immediate situational opportunities in our analysis (see Table 3). Our indicator of motivated offenders (and increasing numbers of motivated offenders over time) is a strong and significant risk factor for chronic crime hot spots, with each additional high-risk juvenile on a street segment more than doubling the odds of membership in the hot spot pattern as contrasted with the crime free pattern. This effect is found despite the overlap in measurement between this indicator and truant juveniles noted earlier. Because of the risk of multicolinearity that this relationship introduces to our model, we also estimated models with each measure alone (see Supplemental material). Other measures included in the regression stay very stable across the different specifications, suggesting that the inclusion of these highly correlated measures is not causing model instability. Moreover, diagnostics for multicolinearity provide additional evidence that serious multicolinearity is not evident in the model.[9] At the same time, both measures remain strong and highly significant, reinforcing the modeling approach that we have taken.

The presence of suitable targets is an even more important dimension in the model. Larger numbers of employees

[9] The initial inspection of VIF shows some concerns of potential colinearity on both high-risk juveniles and truant teens, but in examining the corresponding condition indices and variance proportions of these two variables the diagnostics suggested their inclusion would not seriously impact the overall models (Tabachnick and Fidell 2001).

Table 3 Multinomial logistic regression results of impact of social disorganization and opportunity variables (including change variables) on likelihood of being in chronic crime hot spot trajectory pattern vs. crime free pattern

Variable	*B*	Odds ratio	Beta	Significance
Opportunity				
High-risk juveniles	0.797	2.218	1.675	0.000***
High-risk juveniles (change)	0.217	1.242	0.351	0.002**
Employees	0.072	1.075	9.162	0.000***
Employees (change)	0.031	1.031	3.292	0.000***
Public facilities	0.212	1.237	0.179	0.014*
Residents	0.216	1.241	5.878	0.000***
Residents (change)	0.053	1.055	0.375	0.000***
Total retail sales	0.007	1.007	0.194	0.281
Bus stops	0.605	1.831	0.309	0.000***
Arterial road	2.388	10.870	1.055	0.000***
Police/fire station	0.441	1.555	0.115	0.045*
% vacant land	0.394	1.482	0.040	0.616
% vacant land (change)	1.758	5.803	0.139	0.064
Street lighting	0.085	1.089	0.590	0.000***
Social disorganization				
Property value	−0.350	0.704	−1.263	0.000***
Housing assistance	0.099	1.104	0.457	0.000***
Mixed land use	0.448	1.565	0.093	0.256
Racial heterogeneity	−4.632	0.010	−0.178	0.106
Racial heterogeneity (change)	−4.723	0.009	−0.171	0.085
Urbanization	0.000	1.000	0.000	0.653
Physical disorder	3.244	25.634	1.230	0.000***
Physical disorder (change)	1.820	6.169	0.747	0.000***
Truant juveniles	0.950	2.585	0.792	0.000***
Truant juveniles (change)	0.678	1.969	0.468	0.000***
% active voters	−3.188	0.041	−1.010	0.000***
Other variables				
Segment length	0.020	1.021	0.050	0.516
Spatial lag	0.202	1.224	1.057	0.000***
Spatial lag (change)	0.157	1.170	0.303	0.000***

The table focuses on estimates only from the chronic hot spots trajectory pattern. However, the model estimated includes all seven trajectory pattern comparisons (see Supplemental material)

n=24,023

*p<.05; **p<.01; ***p<.001

on a street segment and a larger residential population (as well as increasing numbers of employees and residential population over time), represent the two strongest risk factors in the model (as indicated by standardized logistic regression coefficients—Beta),[10] and are associated with much greater likelihoods of being a chronic crime hot spot. More public facilities within a quarter mile of a street segment are also a significant risk factor, though total retail sales are not. The two measures of accessibility and urban form also contribute significantly to the models. For each additional bus stop on the street, the odds of being in the chronic hot spots group almost doubles; and being an arterial road increases the odds more than ten times.

While overall our model reinforces the salience of the opportunity perspective, the measures of guardianship that we were able to capture do not follow the outcomes predicted by opportunity theories. Indeed, the presence of police or fire stations within a quarter of a mile of a chronic crime hot spot and increased street lighting appear to be risk rather than protective factors as predicted by opportunity theories. In this case we suspect our findings are spurious. A more reasonable interpretation of these findings is that police and fire stations are expensive infrastructure investments that are placed to maximize coverage of the city's geography and not with crime rates in mind. More street lighting in turn is naturally found in areas where more people and more automobile traffic are found and thus is also likely to be where crime is more serious. Percentage of

[10] The standardized logistic regression coefficient is calculated by multiplying the parameter estimate times the standard deviation of the measure. While there is considerable controversy regarding the interpretation of these standardized coefficients (e.g. see Kaufman 1996), we think it provides a very general sense for comparing the strength of variable impacts across a model.

vacant land was not found to be a risk factor for the chronic crime hot spots pattern.

Informal Social Controls and Crime Hot Spots

The socioeconomic status of a street segment as reflected by higher property values is a significant protective factor in regard to chronic crime hot spots, while increased housing assistance is a significant risk factor. We do not find salience for mixed land use, racial heterogeneity or urbanization. Physical disorder (including increasing physical disorder over time) is another key risk factor. Places with more abandoned tires, dilapidated houses and litter are much more likely to be crime hot spots. However, this does not necessarily mean that physical disorder "causes" crime hot spots, as it may simply reflect other mechanisms that lead to crime problems (Sampson and Raudenbush 1999).

Two additional measures reflecting the ability of communities to exercise informal social controls are also salient factors in our analyses. We find that having a truant juvenile on a block (an indication of "unsupervised" juveniles) more than doubles the odds of that street segment being a crime hot spot. As noted earlier, we used percentage of active voters as an indicator of collective efficacy at the street segment level. In the case where all registered voters are active voters on a street segment as contrasted with a situation where there are no active voters, the odds of being in the chronic crime hot spots trajectory group as compared with the crime free trajectory pattern decreases almost 96 %.

Discussion

Our data illustrate that criminologists, crime prevention scholars, police, and crime prevention practitioners can identify key risk and protective factors that are related to crime hot spots. Emphasis on the importance of suitable targets, motivated offenders, and urban form in understanding chronic crime hot spots does not break new ground, but our work is the first we are aware of to systematically show this empirical relationship at the level of street segments using longitudinal data. In turn, our findings provide empirical support for why hot spots policing programs have been found successful in a number of experimental studies. Simply stated, opportunities for crime play a key part in the production of crime problems at crime hot spots, and as Durlauf and Nagin (2011) argue the presence of the police can deter offenders from taking advantage of such opportunities.

At the same time, our findings suggest that formal social controls, such as law enforcement, may not be the only methods that can bring effective crime control at hot spots, and indeed that such formal controls may not be enough for effectively altering trajectories of crime at places in the long term. If the presence of crime on a street is related to such social factors as poverty and collective efficacy, increasing formal guardianship may provide only short-term solutions to crime problems. Long-term solutions may require that we address the social and structural characteristics of street segments. Economic deprivation, unsupervised teens, and low collective efficacy are all "risk factors" in our analysis for presence in a chronic crime hot spot street segment. An important hypothesis generated from our study is whether by reducing such risk factors or increasing protective factors we could also lower crime. Our data cannot establish this causal chain, but if social disorganization theories are correct, the observational data we present provide strong support for this hypothesis.

The focus on crime hot spots also provides an opportunity to "lower the scale" of social and health interventions. Community prevention has been a key component of crime prevention theory and crime prevention initiatives over the last century (see Farrington et al. 1986; Sherman et al. 1997). Our data suggest that there are opportunities to focus crime prevention at much lower levels of geography, like the street segment. Indeed, the traditional focus on communities or neighborhoods may be both inefficient and unnecessarily stigmatizing for communities. If crime is found on just a small number of streets in a neighborhood, it is misleading to label the whole area as crime prone. If 1 % of the places produce almost a quarter of all crime, greater concentration of crime prevention resources is warranted.

Moreover, it is one thing to attempt to change the social conditions of an entire neighborhood or city. It is another to try to reduce problems on specific blocks. Focusing social interventions more carefully, providing for example, economic support to problematic street blocks and not to neighborhoods overall, may have the potential for ameliorating chronic crime problems in the long term. Indeed, just as prior studies have found that the application of generalized preventive patrol across large areas is ineffective and fails to concentrate police at the hot spots where crime is concentrated (Kelling et al. 1974; Sherman and Weisburd 1995), we might speculate that social programs aimed at large areas like communities are not concentrating resources efficiently. At least in terms of crime outcomes, it may make more sense to concentrate on a few hot spots of crime with more precise or even higher dosages of intervention.

Given the close relationship between place, crime, and health (Fitzpatrick and LaGory 2010), it is equally likely that health-related prevention activities might be more effectively implemented at street segments. Promising prevention programs often fail upon general implementation because they are employed in places which are less risky and more heterogeneous (Welsh et al. 2010). Focusing on hot spots would mean that programs are addressing the neediest places and small areas with homogeneous problems

(rather than larger areas which include very divergent developmental trajectories of crime). It is also plausible that core elements of successful neighborhood level programs such as identifying and mobilizing key leaders, increasing social cohesion, measuring risk and protective factors, and developing interventions (Farrington 1998) can all be used to greater effect when applied at the street segment level.

We think that our results provide support for the application of formal social controls such as hot spots policing, and reason to consider applications of social prevention programs at the local level of chronic crime hot spots. Nonetheless, despite the fact we have gone further than prior studies in identifying crime patterns and risk and protective factors for crime at the street segment level, the retrospective nature of our study meant that we were dependent on data collected for reasons having little to do with crime prevention. Accordingly, our variables could not be defined directly by theory and are often not direct indicators of the constructs we sought to measure. In specific cases, for example in identifying formal guardianship by the police, we could not identify any valid measure for our study. In turn, this also meant that we were not able to specify the interactive processes that are posited in opportunity theories of crime. It is the presence of suitable targets and motivated offenders and the absence of capable guardians at a specific time and place that lead directly to crime incidents. Our study relied on more general summaries of these characteristics across the time periods examined. Moreover, as with observational studies more generally, we cannot draw causal conclusions from our analyses. And we recognize that there are other potential theoretical specifications, for example ones that would posit pathways of effects with opportunity and social disorganization as non-recursive factors, that are not examined here. These limitations suggest the explorative nature of our study, and the need for prospective longitudinal studies of risk and protective factors associated with chronic crime hot spots (Weisburd et al. 2012b).

Conclusions

Our study moves the unit of analysis for understanding the crime problem from people or macro geographic areas such as communities or neighborhoods to micro geographic hot spots. Our data indicate that situational opportunities for crime are strong risk factors for chronic crime hot spots, and accordingly provide explanation for why such strategies as hot spots policing have been found to be effective. But our work also identifies the importance of risk factors reflecting social disorganization at street segments, suggesting that enhancing informal social controls has significant potential for improving the 1 % of streets that produce almost a quarter of the crime problem. In this context, it may be possible to apply social interventions to prevent crime in more manageable and efficient ways by focusing on hot spots of crime rather than communities or neighborhoods more generally.

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