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ORIGINAL PAPER

Making Space for Theory: The Challenges of Theorizing Space and Place for Spatial Analysis in Criminology

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During the 1998 ASC Annual Meeting in Washington, DC Jacqueline Cohen and I (George Tita) approached then-editor of JQC Michael Maltz about our idea for a special issue pertaining to the spatial analysis of homicide. Having worked with a number of scholars as part of the National Consortium on Violence Research (NCOVR) "Space and Time" working group, we were convinced that the *Journal of Quantitative Criminology* was the right "space" for a collection of articles that employed spatial analysis in an attempt to describe and explain the recent "youth homicide epidemic." It was also the right "time"—at the same moment a growing number of scholars began wrestling with explaining the spatial patterns of homicide, especially events involving minority males in urban centers, advances in both desk top mapping solutions (e.g., ESRI's ArcView, MapInfo) and statistical software such as Anselin's SpaceStat were making it much easier to conduct ecological studies of crime and violence. We were thrilled when Michael offered us the opportunity to guest-edit the volume and a year later, "In Search of Diffusion: The Spatial Analysis of Homicide" (Vol 15, #4, 1999) was published.

In this essay, I am joined by a geographer (Steven Radil), who also shares an interest in understanding the role that place plays in explaining the spatial distribution of crime. We briefly explore the relevant criminological literature beginning with the works published just prior to the 1999 special issue and comment on the important contributions and advances achieved since then. Though a formal review of the voluminous literature even on this subset of spatial analysis is far beyond the scope of this paper, we do try to highlight some of the more seminal findings along with more recent works that employ innovative approaches to understanding the spatial distribution of crime. In terms of advancing the field of spatial analysis, we focus on two important issues that are beginning to garner increasing attention within the crime literature: Defining and measuring "place" and the

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adoption of more deductive models that attempt to capture particular processes of influence in the specification of the spatial weights matrix, represented as *W*.

Clearly the development of important theoretical constructs related to the ecology of crime far pre-date the availability of user-friendly, off-the-shelf mapping and spatial analysis software. However, it would be very difficult to overstate the important role these tools played over the last decade in terms of advancing our understanding of the spatial distribution of crime. The mapping of crime incident data permits one to explore how the built environment, the presence of certain types of businesses or activities, or characteristics of the local residential population impact the observed spatial distribution of crimes. The impact of bars, public housing or illicit activities such as gangs or drug markets on local patterns of crime has been of particular interest (Tita and Ridgeway 2007; Taniguchi et al., in press). One can also determine how the spatial distribution of crime changes over different time scales. For instance, in the short term, one might be interested in determining how the policing of drug markets or gang areas might impact the spatial distribution of crime (e.g., Braga 2001; Tita et al. 2003). In fact, using GIS and spatial analysis in the evaluation of such place-based policing strategies has resulted in the robust conclusion that crime does not "move around the corner" and that rather than a displacement effect, we often see a diffusion of the benefits of place-based policing to adjoining areas (Bowers and Johnson 2003; Weisburd et al. 2006). One can also look over longer time periods, and at larger units of analysis, to examine the relationship between changes in the socio-economic composition of local neighborhoods and the spatial distribution of crime (Cullen and Levitt 1997; Morenoff and Sampson 1997; Hipp et al. 2009).

It is worth noting that the term "spatial analysis" applies equally to the study of incident level point patterns (e.g., crime hot spots) as well as to the study of aggregated crime counts or rates at the area level (e.g., spatial autocorrelation among census block groups, tracts, or "neighborhoods"). For our purposes, we focus solely on the spatial analysis of crime at the aggregate rather than the incident level.[1]

Ecological Studies of Crime: The Use of Spatial Regression Models

In their *Editor's Introduction*, Cohen and Tita noted that the growing spatial analysis of crime literature was enabling criminologists to move beyond simply mapping crime and demonstrating that crime does indeed cluster in space. Instead, each of the studies contained in the Special Issue (along with other works from the period, especially Morenoff and Sampson 1997) began to seriously consider why crime clustered in space and search for evidence of diffusion across space. Spatial regression models were being estimated in an attempt to construct, inductively, explanation for the observed patterns of spatial clusters. In addition to crime, researchers began to use spatial regression models to demonstrate that many negative health issues including, but not limited to, low birth weight (Morenoff 2003), infant mortality (Rushton et al. 1996), and depression (Ross 2000) also cluster spatially (for a complete review of the neighborhood effects literature see Sampson

[1] We would be remiss if we did not mention two areas of growing importance. Trajectory models are being employed by a number of researchers to examine the "criminal careers" of communities (Weisburd et al. 2004; Groff et al. 2009). Griffiths and Chavez (2004) used this method to focus specifically on the issue of diffusion. Second, there have been two recent publications within the criminology literature (Cahill and Mulligan 2007; Graif and Sampson 2009) that argue for the primacy of Geographically Weighted Regression (GWR) over "global" regression models. GWR differs in that it does not assume stationarity, thus coefficients are permitted to vary over different regions of one's study area.

et al. 2002). From these studies emerged a consistent set of explanatory variables that characterize "bad" neighborhoods (e.g., concentrated poverty, stability of residents, female headed households, minority population), and that there appeared to be an aggregate effect, dubbed a "neighborhood effect," to living in these places. For instance, concentrated poverty negatively impacts all residents of a community regardless of one's own level of personal income. That such places also cluster in space suggests that neighborhoods are not independent units of observation. On one hand the lack of independence might simply be a result of the clustering of important variables such as race and poverty in space. On the other hand, it was posited that there might be forces at work that make the level of crime in one neighborhood dependent upon the actions and activities occurring in other areas (Sampson 2004; Morenoff et al. 2001). That is, social processes might be at work that result in the diffusion, or contagion of crime, across space over time (for a discussion of the types of diffusion and contagion, see Cohen and Tita 1999).

In trying to further understand the patterns and the spread of violence, spatial regression (or spatial econometrics) quickly became, and remains, the methodology of choice. As noted above, spatial autocorrelation occurs when the values of variables sampled at nearby locations are not independent from each other. This lack of independence makes the use of OLS regression techniques inappropriate. While there are a variety of methods to address spatially autocorrelated data, simultaneous autoregressive (SAR) models have become the most popular, especially spatial error models and spatial lag (or "dependence") models (see Tita and Radil 2010a).

Spatial error models are appropriate for modeling unobservable processes (e.g., norms or beliefs) that are shared among individuals residing in proximate places, or when the boundaries that separate "places" are arbitrary to the extent that two "different" places are actually very similar across various social, economic, or demographic features (i.e., the clustering of like places). The spatial error models takes the following form:

$$Y = X\beta + \varepsilon; \varepsilon = \lambda\varepsilon + u, \text{with } E[u] = 0, E[uu'] = \sigma^2 I,$$

where $\varepsilon = W\varepsilon$, and W is the $(N \times N)$ autocorrelation weighting matrix that contains information about which spatial units (e.g., census tracts, neighborhoods) are spatially connected and λ measures the spatial correlation of the error term. In the absence of correlation among neighbors' error terms, the λ equals zero therefore using OLS methods is appropriate. Failure to account for the non-dependence in the error will still yield unbiased coefficients; however, estimates of the standard errors on those coefficients will be incorrect (Anselin 2002).

When the level of crime in one neighborhood is directly dependent upon the activities or social processes occurring in a neighboring area, one must apply a spatial lag (spatial dependence) model. Failure to consider spatial dependence in one's model is far more serious than ignoring spatially autocorrelated error terms because the model is mis-specified and the estimates of the coefficients are incorrect. The spatial lag model takes the form:

$$Y = \rho WY + X\beta + \varepsilon, \text{with } E[\varepsilon] = 0, E[\varepsilon\varepsilon'] = \sigma^2 I,$$

where ρ is the spatial coefficient on the spatially lagged dependent variable, and it will be nonzero if outcomes in one location influence outcomes in another location. W is once again the $(N \times N)$ autocorrelation weighting matrix.

The autocorrelation matrix, W, is what adds a spatial dimension to the above models allowing the researcher to define which spatial units are related. Though formal statistical models of spatial autocorrelation are relatively new, most crime researchers continue to

rely on the specification of one's spatial weights matrix, *W*, using either spatial contiguity/adjacency or by employing measures of distance decay. The decision to employ such measures is consistent with Tobler's First Law of Geography (Tobler 1970), which states that "Everything is related to everything else, but near things are more related than distant things." Our goal is not to refute this assertion or criticize studies that continue to rely on weights matrices specified in this manner. In fact, there are plenty of theories to support the notion that crime in a focal area influences the amount of crime in immediately proximate areas and in such cases, this is the correct specification of how space matters in *W*. However, we do want to highlight innovative attempts to model crime by recognizing that crime in a focal area may directly influence crime in geographically distant areas.

As we have noted elsewhere (Tita and Greenbaum 2008; Tita and Radil 2010b), the selection of which model, error or lag, has, and continues to be, driven by conducting goodness of fit tests rather than theory. Similarly, in the case of the estimate of spatial lag models, the conventional approach has been inductive by nature as post-hoc explanations of why "space matters" are constructed after the models are estimated. Again, as with the specification of *W* by only considering strictly geographic notions of space, we do want to be overly critical. Empirical exercises to choose one's model and inductive reasoning have added tremendously to the collective understanding of the diffusion of violence. However, as Radil et al. (2010) cautions, it is important to remain vigilant against a sort of "spatial fetishism" in which the ability to simply map crime patterns takes precedence over attempting to explain the causes of the clusters. That is, "When spatial analysis is overly dependent on reasoning from spatial form to social process, the risk of reducing people to the spaces they occupy grows while the likelihood of new insights shrinks" (Radil et al. 2010, p. 308).

As noted above, the theme of diffusion for the Special Issue was motivated by the unprecedented growth in levels of youth homicide during the late 1980s through the early 1990s. As a result, criminologists began to adopt an epidemiological framework and speaking of the contagious diffusion of violence. The simple descriptive analysis of homicide data showed that urban minority males killed with guns represented the subpopulation at greatest risk for victimization. The combination of exploratory spatial data analysis and spatial regression analysis found evidence in support of the conclusion that violence was diffusing at the national level (Blumstein and Rosenfeld 1998; Cork 1999; Kellerman 1996), county level (Messner et al. 1999; Baller et al. 2001; Messner and Anselin 2004), and local levels (Block and Block 1993; Cohen and Tita 1999; Fagan et al. 1998; Kennedy and Braga 1998; Klein et al. 1991; Morenoff et al. 2001).

As we have noted elsewhere (Tita and Radil 2010b), these early studies were important because they began to hint at the structures and underpinnings of social processes that might help us understand why violence diffuses across space. Collectively, these studies also found that the clustering of violence is better explained using spatial lag models (i.e., the result of an unobserved pattern) rather than spatial error models (i.e., the result of the clustering of covariates). By examining the statistically significant coefficient on the spatially lagged dependent variable, specific explanations were offered regarding the forces driving the spread of lethal violence within urban settings. Most frequently, the explanations offered in the above studies included some (or all) elements of the proliferation of crack cocaine markets, an increase in the carrying and use of guns by youths, and/or the emergence of urban street gangs. More recently, the impact of parolees re-entering communities on crime (and recidivism) has been examined (Kubrin and Stewart 2006).

Deductive Spatial Models and Alternative Measures of "Space"

There have been several novel attempts to capture the geographic dimensions of the forces that influence the spread of violence by offering alternative specifications of the autocorrelation matrix. These new techniques take a deductive approach to the modeling specific social processes believed to be driving the diffusion of crime and are based in the "social influence" literature wherein social network analysis has been used to understand the diffusion/adoption of norms or innovations among individuals or organizations (see Marsden and Friedkin 1994; Leenders 2002).

In one of the first attempts to geographically "unbound" the autocorrelation matrix, Mears and Bhati (2006) model homicide by exploiting the finding that social similarity increases the probability of communication and social interaction (see McPherson et al. 2001). The researchers examined race, ethnicity and income at the tract level and linked together the tracts only if the residents were similar. They argue that events in a focal area will be influenced more strongly by events in non-adjacent but socially similar areas than in adjacent, but socially dissimilar areas. The authors find support for this argument and conclude that social distance is important. However, space also matters and the influence of violence in one area has on violence in another is especially powerful when the areas are both spatially **and** socially proximate.

Tita and Greenbaum (2008) and Tita and Radil (2010b) provide examples of how the spatial and social dimensions of urban street gangs can be exploited in an inductive approach. Their research argues that gangs are likely to be especially relevant to diffusion because they are organizations that are sustained over time through continuing social interactions within specific geographic locations and because the area in which gangs hang out experience high levels of crime, especially violence (Kennedy et al. 1997; Tita and Ridgeway 2007.) Their inductive models of violence exploit social network data on gang rivalries along with the location of gang "set space" (Tita et al. 2005). Using matrix algebra, an autocorrelation matrix (W) is constructed wherein a non-zero value indicates that a pair of geographic units contains the set space of rival gangs. The results from studies in Pittsburgh and Los Angeles were consistent in demonstrating that the weights matrix that considers the socio-spatial nature of gangs and their rivalries provides a better fit to the data.

Different types of violence/crime will require different theories and different specifications of the spatial autocorrelation matrix. For instance, one might model the diffusion of youth violence by considering social interactions that occur within schools. In such a case neighborhoods would be linked together if and only if they send students to the same school buildings. Though Meares and Bhati (2006) have strong theoretical justification for modeling patterns of influence using measures of similarity, studies that capture the social networks and communication networks would provide an empirical validation of their approach. In fact, a recent publication in the journal *Science* provides an excellent template for how such a study could be accomplished.

Interested in testing the relationship between community level economic development (employment) and interpersonal social networks, Eagle et al. (2010), are able to measure the patterns of social interactions for the entirety of the United Kingdom. Each year in August, the "from" and "to" locations for over 99% of the land line telephone calls and over 90% of all cell phone calls are recorded. The researchers used this dataset to test the "strength of weak ties" argument (Granovetter 1973) by examining the level of social, economic and demographic (dis)similarity between the locations of the communicating

parties. Their analysis demonstrates that communities that place calls to others who reside in places heterogeneous from their own fair much better economically.

One could imagine using geographically identified communication data for a variety of reasons within the community and crime literature, in general, in the spatial analysis, in particular. As used in the original article, the communication patterns could be used to construct community-level measures of "bridging" versus "bonding" social capital (see Tita and Boessen, forthcoming). It could also be used in the construction of spatial autocorrelation matrices. One could create a simple binary matrix in which two areas were identified as "neighbors" if the number of calls linking the two areas exceeded a user set threshold. Measuring the frequency of calls between two areas would permit one to capture the strength of the link between the two communities. Using this information would result in a correlation matrix that explicitly includes a weighted measure of the potential for activities in one area to influence crime in another based not on geography, but on the social distance between places.

Defining Place for Spatial Analysis

As noted above, spatial approaches in criminology have a long history of drawing upon geographic concepts, and later, geographic technologies. One particular way in which geographers and criminologists have tried to understand the behavior of social actors is through the concept of place. Place is one of the most central concepts in geography (e.g., Relph 1976; Tuan 1977; Entrikin 1991; Sack 1997; Staeheli 2003; Cresswell 2004) and a great deal of research in spatial criminology makes use of different aspects of the place concept, albeit sometimes uncritically. As such, we begin with a discussion of the place concept, how it is used in different research traditions in geography, and how such approaches can inform current and future research in criminology.

Place seems simple enough on the surface but a great many scholars have struggled to describe and define exactly what is place. As noted by Staeheli (2003), Cresswell (2004) and others, place is a multifaceted concept and often used in different ways within different research traditions. For example, Staeheli (2003, p. 159) identifies different but interrelated perspectives on place within geography: place as a physical location or site; as a cultural and/or social location; as context; as something socially constructed over time; and as an ongoing process. These various elements and perspectives on place should be read as fundamentally interrelated although some are more prominent than others. For example, nearly all contemporary work explicitly involving place in human geography proceeds from assuming that places are socially constructed and are the products of human activity. From this starting point, the research questions involving place range from ideographic approaches that emphasize the distinctiveness of a given place to those that attempt to explain such uniqueness by reference to wider political or economic processes or structural conditions (Cresswell 2004).

As noted by Staeheli (2003), understanding place as a specific physical location or an otherwise bounded site is a common approach, especially within spatial analytic traditions in geography. Expressly spatial approaches are often framed as the study of relationships that connect discrete places (e.g., Staeheli 2003). In other words, in this tradition, places are typically seen as discrete locations in a spatial setting. However, this tradition also deemphasizes the uniqueness or distinctiveness of places and a consideration of place becomes a question of research design: how to select observation locations or sites for

research. Places then are defined primarily spatially. The issues focus on how locations are bounded in space, how distant sites are from each other on a spatial plane, etc.

Another approach to place familiar to the ecological tradition in criminology is to see place as context. This approach also has been important in many different subfields of geography and tends to see places as part of a broader environmental context which one must consider to fully understand human action (which of course occurs within 'places', i.e. specific locations). The characteristics of places are typically understood as potential 'variables' for a statistical/spatial analysis in this approach in geography, criminology, and many other fields of study (see O'Loughlin 2000, 2003). The place as context approach is neither new nor exclusive to geography (see for example Émile Durkheim's (1897) research on the environmental and personal factors associated with suicide). However, understanding place as context tells one little about the appropriate way in which to define a place or a series of places for systematic study.

These two perspectives on place are at the heart of an emerging technical discussion in criminology about the importance of considering the proper level of aggregation when estimating neighborhood effects for spatial modeling (see Hipp 2007; Wiesburd et al. 2008; Braga and Wiesburd 2010). As Hipp (2007) points out, in the ecological tradition in criminology, data is typically aggregated to geographic areas which vary in size and configuration, such as census units, which typically serve as the units of analysis for spatial models. Taking this approach to the study of crime leaves one confronted with the challenges of the modifiable areal unit problem, or MAUP [Openshaw and Taylor 1979, 1981; Openshaw 1984; see Gehlke and Biehl (1934) or Robinson (1950) for classic examples of MAUP, or Openshaw (1996) for a more contemporary review]. The modifiable areal unit problem arises from the fact that areal units are usually arbitrarily determined in the sense that they can be aggregated or disaggregated to form units of different sizes or spatial arrangements (in other words, they are 'modifiable'). MAUP involves two interrelated elements, the scale problem and the zoning problem (Openshaw and Taylor 1979). Openshaw and Taylor (1979, p. 128) describe the scale problem as "the variation in results that may be obtained when the same areal data are combined into sets of increasingly larger areal units of analysis," and the zoning problem as "variations in results due to alternative units of analysis where n, the number of units, is constant." For the scale problem, increasing the aggregation of units by increasing the area covered by the units (which also typically involves decreasing the total number of units for a given area) decreases the variance in the data between the units. For the zoning problem, rezoning the areas contained by each unit while holding the total number of units the same can impact both the mean and variance of any measured data.

These issues have important implications for ecological studies of crime as multivariate statistical analyses can be sensitive to variations in scale and zoning systems, leading to highly unreliable results (e.g., Fotheringham and Wong 1991). The problems posed for statistical inference from MAUP have led some to conclude that all methods whose results depend on areal units should be discarded and techniques independent of areal units should be used (e.g., Tobler 1989; see also Openshaw and Taylor 1981; Openshaw 1984; Fotheringham 1989; Fotheringham and Wong 1991; Fotheringham and Rogerson 1993). Grid-based models have also been advocated in spatial analysis to avoid the use of inconsistently sized areal units but the issues of the choice of grid size and the associated level of aggregated information remains. Hipp's advice is not as extreme as Tobler's (1989), but he does advocate that analysts should carefully consider whether a particular geographic unit of analysis "is actually appropriate for the outcome of interest or the structural predictors being used" (2007, p. 660). Given that there remains no technical solution to the problems

posed by MAUP, Hipp's (2007) advocacy for theory to guide one's choice of the appropriate spatial unit of analysis is crucial.

In response to a growing recognition of the need for a careful consideration of the concept of place and of how place can be operationalized for the systematic study of crime, Hipp (2007) argues for a move toward using geographically smaller units of analysis and, correspondingly, less aggregated data in the spatial analysis of crime (see also Hipp et al. 2009). For example, Hipp (2010) describes a unit of analysis for spatial modeling that he calls "micro-neighborhoods" which consist of around 10 households. The obvious size reference ("micro") in Hipp's (2010) unit of analysis suggests the utility of another geographic concept, that of scale, when considering the question of defining and operationalizing place for systematic analysis. Scale, which refers to the geographic scope or reach of a given phenomena (see Marston et al. 2005), is necessary to consider when attempting to specify any geographically-based unit of analysis. In other words, scale is implicated in thinking about how places are bounded in space. However, scale has also been heavily critiqued in recent debates in human geography about the nature of the concept and its utility in geographic research (e.g., Herod and Wright 2002; Mamadough et al. 2004; McMaster and Sheppard 2004; Marston et al. 2005).

The arguments about scale focus on the geographic reach and scope of the social activities that are presumed to form places and how such scales can be and are routinely created, maintained, and marshaled by people for certain political and economic agendas (e.g., Taylor 1982; Smith 1992; Swyngedouw 2004). An important element of these critiques for this discussion is that the larger the scale that one chooses to focus upon to define a place or to otherwise bound or delimit a place, the more likely it is that the specific issue of interest can be obscured from the analyst by processes operating at various other scales and in various other places (e.g., Massey 1997). The broad point for criminology from these debates is that analysts should be ever cautious of uncritically using arbitrary or pre-given units for analysis or of assuming that such units can or should be thought of as 'places'. The reference to micro-scale units in criminology research (e.g., Hipp 2010) evokes this point and the scale/place debates in geography help draw attention toward careful and theoretically informed thinking of about places.

The move toward smaller scale units of analysis can be seen as perhaps driven by the technical issues of data collection and levels of aggregation (e.g., MAUP) but should also be one in which the insights of the scale/place debates are considered. A careful read of the technical and theoretical issues involved with delimiting space for systematic study makes it clear that it is "geographical scale that defines the boundaries and bounds the identities around which control is exerted and contested" (Smith 1992, p. 66). In short, the scales used to delimit places that could be used as units of analysis are products of myriad human action and goals. Places, therefore, are never natural, preformed, or given and there is no such thing as the 'right' scale for any given research topic or interest. Hipp (2007, 2010), Hipp et al. (2009), and others are to be commended for suggesting approaches that consciously attempt to deal with the challenges posed by MAUP. But just as with grid-based approaches, the 'smaller is better' micro-scale approach to place in criminology must still wrestle with the problems of place as something that is ultimately socially constructed and therefore contested and subject to change as well as with the perhaps more familiar technical issues of MAUP.

Given the combination of the realities of the high costs of collecting data and the general availability of census data, it is unlikely and perhaps unreasonable to expect that criminologists will abandon the use of geographic units with some amount of aggregated data (such as census units). Accordingly, there are some innovative advances being

undertaken which rely upon capturing the spatial dimension of social networks to define the geography of a community.[2] For example, Radil et al. (2010) and Tita and Radil (2010b) focus on territorially-based rivalry relationships as a way to capture place-to-place interactions between gangs. Using responses from a survey that asked police along with current and former gang members to identify the rivalry relationships between a set of 29 different gangs, the authors find that the complex web of rivalry relationships, some of which stretch relatively long distances over space, is an important factor that explains the spatial distribution of gang-related violence and that connections between census units based on rivalry are better predictors of the overall spatial pattern of violence than are connections based on distance or proximity.

Another example is found in the work of Grannis (2009) which posits that street and road networks shape social interaction and thus neighborhoods. Grannis refers to areas defined by interconnected small "tertiary streets" as "T-Communities" and argues that social ties form among individuals who come into physical contact with one another by walking along, or crossing tertiary streets. Grannis (2009) notes that unlike communities defined by boundaries drawn for administrative purposes (e.g., census tracts, zip codes), T-Communities represent a much more realistic definition of a community. By carefully examining local tertiary streets and their effect on the structure of social networks, Grannis suggests that researchers can begin to understand the process by which communities develop social capital for creating and maintaining safe communities (2009).

Conclusion

There have clearly been a number of important advances in the spatial modeling of crime at the aggregate, place-based level over the last 25 years. Looking back, one is hard pressed to even identify the existence of expressly spatial analytic approaches to understanding crime until the concurrent development of and widespread access to both desktop mapping and spatial statistical software in the early to mid-1990s (e.g., desktop GIS packages and spatial software such as SpaceStat). It is clear that we have come very far in a relatively short period of time. In fact, we've come so far that it is now difficult to argue that the most pressing needs for the future of the spatial analysis of crime are either technological or methodological in nature. It is our conclusion that the most pressing issues remain to do with the sound theorization of human behavior and crime in geographic space and with making sure that the now sophisticated spatial methods that we do use are those that flow from and are informed by theory.

As it turns out, this is an old dilemma for spatial analysis. For example, it was more than 30 years ago that geographer Piers Blaikie (1978, p. 276) took stock of the state of affairs of diffusion research in geography and remarked that the application of sophisticated quantitative spatial techniques "has been more concerned with the techniques themselves than what they tell us about the process of spatial diffusion. The preoccupation with spatial form without an adequate theory of process has meant that the progress in technique has not been able to help progress in theory." Blaikie (1978, p. 276) concluded that methods should be a secondary concern "until a satisfactory theoretical framework [for diffusion] is

[2] A move toward using social networks (either empirically or conceptually) is also evident in geography where concerns about the problems with scale have led some to turn to network models of social process (notable examples from a variety of geographic sub-disciplines include Cox 1998; Amin 2002; and Flint et al. 2009).

devised." Unfortunately, things may not have changed as much as we would hope. Arthur Getis, a foundational figure in spatial analysis, recently argued that overly simplistic notions of the importance of distance to human activity (which he traces to 19th century 'least effort' theories of human activity; see also Isard (1956)) continue to underpin most spatial modeling research and that "unfortunately for the discipline of geography, no substantial work about distance theory has occurred since the 1960s and early 1970s" (Gettis 2009, p. 407).

From these perspectives, the challenges for future work are not those that pertain to the development of new mapping technologies or more sophisticated statistical methodologies (e.g., geographically weighted regression, the development of Bayesian methods in spatial analysis). The most pressing issues remain connected to the theorization of spatial human behavior. The most important developments have, and continue to occur, within the realm of theory and good science. That is, regardless of how sophisticated our methodologies become for the estimation of spatial models, the key will always be that the specification of these models be sound in terms of the measurement and definition of place and the manner in which areas are deemed "neighbors."

In using spatial regression methods to explain crime patterns, we are respectful that researchers relying on official sources of data such as the Census Bureau will forever be hamstrung by the availability of meaningful covariates that are aggregated to the appropriate level of crime. Being mindful that place is often socially constructed and that various criminological theories suggest social processes that operate at different spatial resolution is all the more important. It is also vital that, in the case of spatial lag models, one must carefully consider the full geographic extent in which the events in one area can influence events in other areas regardless of the geographic distance between them. Though the ability for a crime in a focal area to influence crime in other areas might decay over distance, it is possible that there are other networks of social interactions (e.g., interactions that occur outside the neighborhood at work or school, participation in voluntary or religious organizations, adversarial networks as presented in our gang example) that make events in one area extremely salient in the commission of future events in otherwise geographically distant areas.

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