# Chapter 10

## Abstracts of Additional Papers:

## Beyond Euclidean Maps: Simultaneous Thinking, Networks and Rushton's 'Leitwissenschaft' (a leading or guiding science)

*Rudy Banerjee*

Gerard Rushton developed a pioneering effort in geographic thought that has been under-identified in the field. However, developments in operations research and complexity science are providing evidence of his insights within a wider framework in geography. Ever since his publication of simultaneous effects on central places, which invalidates the neat geometric primitives of one-at-a-time sequential process of central places, location science has tackled the complexities of real world processes that are neither 'central' nor 'places' nor Euclidean but have a combination of behavior, space and environmental interactions. The simultaneous considerations required to tackle such complex dynamics were recognized early on by Rushton, and these have continued to affect not only location science but also epidemiology, GIS, health geography and economic geography.

In this presentation, I will provide a series of examples on how Rushton challenged the sequential hypothesis in geographic problem solving, and applied the

simultaneous thought process that is evident in complexity science and recognized in operations research as the basis for optimal solutions. I will review his pioneering efforts in Medical Geography, especially the paper: Rushton, G. and P. Lolonis (1996), "Exploratory spatial analysis of birth defect rates in an urban area," Statistics in Medicine 15, 717-726. Here, he applies the simultaneous thinking paradigm, adapting his post-central place approach, to solidify what I would label as Rushton's 'Leitwissenschaft' (a leading or guiding science).

# Spatial Filter Method for Disease Cluster Detection, beginning with Gerard Rushton's 1996 article entitled, Exploratory spatial analysis of birth defect rates in an urban area

*Qiang Cai*

Rushton published the aforementioned paper in Statistics in Medicine in 1996, and it has become a highly influential paper, cited 180 times to date. The paper introduced the spatial filter method with three key components: A fine resolution regular lattice of grid points to cover the study area; fixed distance circles around each grid point as basic units for disease rate estimation; and Monte Carlo simulation to test the statistical significance of disease rates at the grid points.

I based my dissertation research entitled, Mapping Disease Risk Using Spatial Filtering Methods, on his 1996 paper with several extensions. I extend regular grid points to variable grid points; fixed distance circles to spatially adaptive circles; and the Monte Carlo test to include calculations of power and false discovery rate.

Software (DMAP IV) was developed to implement the extensions of the original spatial filter method. A recent publication by Cai and Rushton summarizes these new developments of the spatial filter method, in "Validation tests of an improved kernel density estimation method for identifying disease clusters", Journal of Geographical Systems, 2012.

# Spatial Efficiency of Central Place Systems under the Manhattan Metric

*Panos Lolonis*

This paper analyzes systematically the spatial efficiency of indicative types of central place systems that are commonly discussed in the Central Place Theory (CPT) literature. The analysis is centered on two interlinked concepts that have marked Rushton's research work, namely, spatial efficiency and distance travelled to service centers. Particular emphasis is placed on measuring the decrease in spatial efficiency, as defined by Fisher and Rushton (1979), in typical arrangements of central places and service areas by adopting the Manhattan metric as opposed to the Euclidean metric. Analyses are at a theoretical level, keeping most CPT assumptions constant in order to illustrate the magnitude of spatial inefficiencies introduced by the Manhattan metric and to highlight certain irregularities that are expected to arise in the provision of services and goods under certain special cases. The functional forms and the spatial efficiency values have been computed for several typical cases. The underlying goal of this work is to determine whether the Manhattan-like transportation networks observed in the real world act as a distorting factor in central place systems and inhibit us from testing the functioning of CPT mechanisms in reality.

# Right Choice of Choice, Wrong Choice Timing: Gerry Rushton moved on too soon?

## *Jordan Louviere*

Gerard Rushton introduced me to modeling choices. The UMTA transportation planning course introduced me to econometric choice models. I studied psychology to better understand why and how people choose. A chance encounter off the coast of Fiji led me to MIT and Dan McFadden's group, and I eventually taught in the MIT summer choice modeling course for 23 years. By that time Gerry had chosen to move on.

I was invited to Australia in 1977 to help setting airfares for Qantas, which led me to integrate: (1) Information Integration Theory and Conjoint Measurement; (2) probabilistic discrete choice models; (3) discrete multivariate analysis for contingency tables; and (4) experimental design methods that evolved into discrete choice experiments. I have worked in this area since then.

I have consistently worked on external validity, and I moved out of psychology due to a lack of interest in relating the theory and methods with what real people do. The Arrow-Solow Committee invited me to address the 1994 Conference on the Future of Contingent Valuation. I have since worked in applied economics, and my work has had global impact on non-market valuation.

Gerry's interest in the method of paired comparisons and MDS kindled a life-long interest in measurement. I became convinced that only theory-based measures were scientifically useful, and eventually developed a measurement method known as Best-Worst Scaling

(BWS). Tony Marley I and others have spent over a decade on the theoretical underpinnings of BWS, with a book published in 2015 by Cambridge University Press.

I returned to my roots in individual preferences and choices in 2003 using BWS as a way to study and model single individuals' behaviors. New estimation methods insure model convergence for single individuals, which we are applying to model individual wheat buyers in several countries to understand how wheat characteristics influence their choices, which should lead to better crop selection and planting choices by farmers. Finally, thanks to funding from SSHRC, Tony Marley, Towhidul Islam and I are extending the study of discrete choice to quantity choices (2 of X, 4 of Y, none of the rest) and testing the resulting data and models against actual purchases from the same people provided by a major panel company.

So, thanks to Gerry's inspiration and guidance, I am still working on choices, including pioneering some new and innovative ways to think about and model the choices that people make.

# On Structures, Agency and Chance: Reflections on the Advisor-Student Relationship

## *John Mercer*

The relationship between faculty advisors and graduate students is complex, involving the structures of higher education, institutions and disciplines, as well as the actions of both advisor and student. Chance is always present in the interaction. I explore this relationship through the geographical and historical narrative of two agents: Gerard Rushton as the advisor, and myself as the student.

Advisors shape the intellectual and career development of their students as well as recommend the research pathways that can last a lifetime. They are typically crucial role models. For me, the first of these two capacities was the more important, although Rushton had a lasting influence on my general methodologies, such as working with large data sets, but less so in terms of specific research questions or agendas.

We met by chance at McMaster University in 1964, this being Rushton's first academic appointment. I was a new master's student who was committed at that time to return to the UK for the Ph.D. degree. Though not my primary advisor, he soon changed my thinking and actions with dramatic effect, thereby converting me into a North American geographer rather than a British geographer. He literally changed my life. His course on location theory, advice on my housing research, and wider conversations led to my becoming a scientific geographer,

engaging in quantitative description and locational analysis.

After becoming Rushton's doctoral student in 1966 (he then left for Michigan State in 1967), our continuing relationship was expressed and embedded in a series of external structures and particular acts by both of us, which I more fully discuss in the paper. Coincidentally, we became faculty colleagues at the University of Iowa from 1969 to 1973; we have remained friends ever since.

# Emphasizing the Importance of Geographical Information in Making Disease Maps: Implications for GIS and Public Health Surveillance

*Chetan Tiwari*

Rushton and Lolonis in their paper entitled "Exploratory spatial analysis of birth defect rates in an urban population", show that the ability to locate and manipulate objects in geographic space via GIS should be an explicit part of the disease mapping process. Their paper makes several key contributions: (1) A method for mapping disease rates as continuous spatial distributions rather than constrained by administrative boundaries; (2) the use of simulations to map the statistical significance of rates; (3) the use of overlapping spatial filters as a mechanism to account for spatial autocorrelation; and (4) the potential utility of disease mapping as decision support aids for public health surveillance. They suggest novel approaches for the integration of GIS and public health surveillance. These include the development of systems for decision-makers to 'walk the street' using virtual GIS-based software: and knowledge-based spatial analysis systems that would make tentative conclusions about disease clusters.

My research builds on the ideas first proposed by Rushton and Lolonis. In collaboration with Rushton and graduate student colleagues from the University of Iowa, we have developed adaptive spatial filters that dynamically adjust in size to account for differences in population density. Further efforts to improve the

geographic resolution of the map include methods for optimizing the placement of spatial filters across geographic space. Other methodological improvements include the ability to adjust for population differences in age and gender within each spatial filter. Methods for tracking and maintaining consistent filter sizes over multiple data files will permit temporal comparisons of disease patterns. The common thread among all these improvements builds on one key conclusion of their paper: "There needs to be a better balance in research between efforts that involve improving geographic information, and those that involve improving methods of statistical analysis".

Although we have made initial progress in incorporating these methods into semi-automated public health surveillance systems, there is much work that is still needed to realize the development of knowledge-based systems and interactive virtual GIS environments.