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THE RECENT INTELLECTUAL STRUCTURE OF GEOGRAPHY*

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ABSTRACT. An active learning project in an introductory graduate course used multidimensional scaling of the name index in *Geography in America at the Dawn of the 21st Century*, by Gary Gaile and Cort Willmott, to reveal some features of the discipline's recent intellectual structure relevant to the relationship between human and physical geography. Previous analyses, dating to the 1980s, used citation indices or Association of American Geographers specialty-group rosters to conclude that either the regional or the methods and environmental subdisciplines bridge human and physical geography. The name index has advantages over those databases, and its analysis reveals that the minimal connectivity that occurs between human and physical geography has recently operated more through environmental than through either methods or regional subdisciplines. *Keywords:* active learning, Geography in America, human geography, multidimensional scaling, physical geography.

Study of geography's intellectual structure is an essential part of the process through which geographers continually re-create their discipline. Analysis of data that act as proxies for intellectual structure can adjudicate among competing, often idealistic and normative, models that place particular subdisciplines at the disciplinary core or cores and relegate others to the periphery. Such analyses can stimulate more grounded discussion about the opportunities and constraints involved in disciplinary restructuring. A multidimensional scaling (MDS) of the name index in *Geography in America at the Dawn of the 21st Century*, by Gary Gaile and Cort Willmott (2003), provides such an analysis and also contributes to pedagogy by illustrating how graduate students in an introductory course can engage in collaborative, active learning to make an original research contribution.

COMPETING MODELS OF INTELLECTUAL STRUCTURE

Many geographers have conjectured about the intellectual structure of the discipline. The resulting models, though not based on systematic analyses of proxy measures of intellectual structure, represent much more than ungrounded speculation. They are based on long experience in the discipline and broad reading of its literature.

In one of the classics among such models, William Pattison (1964) proposed that four complementary "traditions" structure geography's disciplinary identity: spatial, area studies, man-land, and earth science. Those traditions allegedly inter-

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connect what otherwise may seem like intellectually unrelated endeavors. In specific reference to human and physical geography, they evidently connect through the spatial and area-studies traditions but not through the man-land tradition: "Human or cultural geography turns out to consist of the first three traditions [spatial, area studies, and man-land] applied to human societies; physical geography, it becomes evident, is the fourth tradition [earth science] prosecuted under constraints from the first and second [spatial and area studies] traditions" (p. 216).

Other geographers, whether primarily involved in human or physical research, have more recently proposed that the discipline lacks any such unifying structure. David Stoddart (1987), a physical geographer, lamented that physical and human geography form two intellectual isolates trapped in the same institutionalized discipline. R. J. Johnston (1983a), a human geographer, also argued that physical and human geography form two largely distinct intellectual communities. And B. L. Turner II (2002, 53) provides a complementary assessment from the perspective of human-environment geography, arguing that "fermentations in the academy are threatening to splinter the precarious rationale that has held geography's parts together over the last half of the twentieth century." The various reasons proposed for that supposedly ongoing dissolution of disciplinary structure include reductionistic and nomothetic pressures, the associated decrease in spatial scale of analysis, increasingly demanding and narrow methodologies, and broader institutional and intellectual trends such as changes in the National Academy of Sciences and the modernist epistemological separation of nature from society (Gaile and Willmott 1989, xxx–xxx; Sluyter 2002, 227–230).

But other scholars argue that the emergence of such phenomena as global warming, which seems as intellectually intractable to the natural and social sciences in isolation from each other as it seems threatening to society, has stimulated reintegration of geography's subdisciplines. The report of the National Research Council (NRC), *Rediscovering Geography: New Relevance for Science and Society* (NRC 1997, 28–29), defines modes of analysis (integration in place, interdependencies between places, and interdependencies among scales) and representation (visual, verbal, mathematical, digital, and cognitive) that geographers characteristically apply to three categories of phenomena: environmental dynamics, environmental/societal dynamics, and human/societal dynamics. Although the NRC report thus uses terms that differ from Pattison's, it echoes his idealization of an intellectual structure that binds the subdisciplines to core phenomena and modes of analysis that largely correspond to his spatial, area studies, man-land, and earth science traditions. Unlike Pattison, however, the NRC surmises that physical and human subdisciplines focus on qualitatively different types of phenomena but overlap in the environmental subdisciplines (Pattison's man-land tradition), with the regional and methods subdisciplines providing further connectivity—analytical and representational—across scales and types of phenomena. Such an intellectual structure seems ideal for the study of social/natural phenomena like global warming, thus conferring the putative renewal of relevance.

Geography in America at the Dawn of the 21st Century, in contrast to its predecessor, *Geography in America* (Gaile and Willmott 1989), echoes that belief in a recent increase in disciplinary integration (2003, 2). In the newer volume the editors assign each subdiscipline's chapter to one of seven parts (Table I), the first three of which are the NRC's three categories. Moreover, the editors conjecture that environmental geography is increasingly creating connectivity between physical and human geography: "A growing number of geographers have begun to bridge the gaps between science and social science approaches in order to study the links (and feedbacks) between society and the environment" (p. 8). They also seem to suggest that the regional subdisciplines play a "central role" in providing connectivity among other subdisciplines (p. 11).

Book reviews of the 2003 *Geography in America*, however, point out that its editors' claim of renewed disciplinary integration is based more on conjecture than on analysis of data. Johnston (2004, 1004) notes that, despite the "boosterist rhetoric" regarding a "more unified" discipline, "little evidence is provided to sustain that claim." Similarly, Michael Conzen (2005, 141) concludes that disciplinary "unity is mostly argued by assertion."

ANALYSES OF PROXIES OF
INTELLECTUAL STRUCTURE

In an effort to adjudicate among such competing models, geographers have analyzed subsets of the disciplinary literature and other databases as proxies for selected aspects of intellectual structure. Johnston (1983b), for example, performed a qualitative content analysis of the literature of resource geography in the early 1980s to test for connections between human and physical geography . . . but found few. More recently, he used data from the 2001 Research Assessment Exercise to quantify

TABLE I—STRUCTURE OF *GEOGRAPHY IN AMERICA*,
SHOWING THE EQUIVALENT TERMS USED IN
FIGURE 1, TABLE II, AND THE TEXT

PART OR CHAPTER TITLE	EQUIVALENT
1. Introduction	
I. ENVIRONMENTAL DYNAMICS	
2. Biogeography	Biogeog
3. Climate	Climate
4. Cryosphere	Cryo
5. Geomorphology	Geomorph
6. Mountain Geography	Mountain
II. HUMAN/SOCIETY DYNAMICS	
7. Cultural Geography	Cultural
8. Cultural Ecology	CAPE
9. Economic Geography	Economic
10. Environmental Perception and Behavioral Geography	Perception
11. Historical Geography	Historical
12. Political Geography	Political
13. Population Geography	Population
14. Sexuality and Space	Sexuality
15. Socialist Geography	Socialist
16. Transportation Geography	Transport
17. Urban Geography	Urban
III. ENVIRONMENT/SOCIETY DYNAMICS	
18. The Human Dimensions of Global Change	HD
19. Water Resources	Water
20. Energy Geography	Energy
21. Coastal and Marine Geography	Coastal
22. Contemporary Agriculture and Rural Land Use	Agriculture
23. Rural Development	Rural

Source: Gaile and Willmott 2003.

the distinctiveness and separation of the literatures that human and physical geographers in the United Kingdom produce (Johnston 2003). Anthony Gatrell and Anthony Smith (1984) used MDS to analyze the structure of citations in twenty-two

geographical journals for 1970–1972 and 1980–1982, revealing a decline in connectivity between regional science and other subdisciplines as well as other aspects of intellectual structure. Jeffrey Smith (2003, 21), who surveyed the 1998/1999 membership of the Cultural Geography Specialty Group of the Association of American Geographers (AAG) to determine what connections cultural geographers have with other subdisciplines, concluded that “today’s cultural geographers continue to maintain ties to a wide variety of the discipline’s subfields.” And Gregory Bierly and Jay Gatrell (2004, 340) compared the faculty composition of geography departments in 1991 and 2001 to reveal a minor shift of disciplinary resources from human to environmental geography, methods, and physical geography.

The two most comprehensive analyses to date have been Michael Goodchild and Donald Janelle’s (1988) application of MDS to another proxy for intellectual structure, the 1984 membership rosters of the AAG’s specialty groups, and Andrew Bodman’s (1991) similar use of the Science Citation Index (SCI) and Social Sciences Citation

Index (SSCI) for 1984–1988. Unlike studies based on subsets of the geographical literature or AAG membership, those two analyses yield insight into the comprehensive intellectual structure of geography during the 1980s. Goodchild and Janelle (1988, 13) concluded that the physical and human subdisciplines form distinct clusters “with no apparent overlap” and that the environmental and methods subdisciplines (“resource and technical specialties,” in their terminology), “provide a hinge

TABLE I, continued

PART OR CHAPTER TITLE	EQUIVALENT
IV. GEOGRAPHIC METHODS	
24. Geographic Information Systems	GIS
25. Remote Sensing	RS
26. Cartography	Cartography
27. Mathematical Models and Quantitative Methods	Quantitative
V. GEOGRAPHERS AT WORK	
28. Geography Education	Education
29. Hazards	Hazards
30. Medical geography	Medical
31. Military Geography	Military
32. Aging and the Aged	Aging
33. Recreation, Tourism, and Sport	Tourism
34. Applied Geography	Applied
35. The History of Geography	HOG
VI. REGIONAL GEOGRAPHY	
36. Geography of Africa	Africa
37. American Ethnic Geography	Amer. Ethnic
38. American Indian Geography	Amer. Indian
39. Asian Geography	Asia
40. Canadian Studies	Canada
41. Geography of China	China
42. European Geography	European
43. Latin American Geography	Latin America
44. Russian, Central Eurasian, and East European Geography	Russia
VII. VALUES, RIGHTS, AND JUSTICE	
45. Values, Ethics, and Justice	Values
46. Human Rights	Rights
47. Geographic Perspectives on Women	GPOW
48. Geography of Religion and Belief Systems	Religion

relationship between the broad human and physical divisions.” Moreover, they characterized regional subdisciplines as connected more to other subdisciplines than to one another. Bodman (1991, 34–35), in contrast, concluded that the regional subdisciplines provide most of the connectivity between the largely separate physical and human cores. Those quite different conclusions suggest that either AAG specialty-group rosters or citation indices, perhaps both, have limitations as proxies for intellectual structure.

ACTIVE LEARNING

During the fall semester of 2004 the incoming students in the geography graduate-degree programs at Louisiana State University carried out a class project designed to build on such existing analyses. The purpose of the class, “Introduction to Research Methods in Geography,” taught by Andrew Sluyter, is similar to that of many such courses in North America: to introduce graduate students to the discipline so they can situate themselves within its existing intellectual structure and carry out original, significant, rigorous geographical research that will result in a thesis or dissertation worthy of an advanced degree. Of the twenty-one students, nine were doctoral students, twelve were master’s students; seven were oriented toward human geography, eight toward physical geography, and six toward methods. Such diversity demands a focus on broadly relevant epistemological issues rather than on the details of techniques specific to particular subdisciplines. Readings from the 2003 *Geography in America*, which features forty-seven chapters written by representatives of the AAG specialty groups, served to link discussion of those abstract issues to concrete examples of research problems, types of data and analysis, and results.

To learn how to conduct original research and how their varied subdisciplines could collaborate, the graduate students worked together to answer a question relevant to the course goals: What are the interrelationships of geography’s subdisciplines? The project involved literature review, discussion, and individual term papers, but the class also directly analyzed data relevant to understanding disciplinary intellectual structure in order to create knowledge about it. The literature on collaborative, active learning suggests that such concrete class projects result in deeper understanding of abstract epistemological debates (Healey and Roberts 2004).

To make the project manageable within the time and resources available, Sluyter specified that the data must come from the primary course text: the 2003 *Geography in America*. Through a series of discussions, both with the class as a whole and in smaller working groups of four or five participants, the graduate students learned to work together to answer the question. After considering a range of methods, the class ultimately concluded that the lengthy name and subject indexes, each of which comprises twenty-six pages, virtually compelled a quantitative approach. Those indexes have similarly beguiled others, such as one book reviewer’s counting and measuring of indicators such as the column inches related to selected topics in the subject index (Conzen 2005). The graduate students chose to perform a more systematic and focused analysis.

MULTIDIMENSIONAL SCALING

The analysis employed the MDS functionality of the Statistical Package for the Social Sciences (SPSS 2003) to determine the structure of the names, mainly those of authors, shared between pairs of chapters (Table II). Representatives of each AAG specialty group wrote a chapter, and specialty groups emerge out of (rather than are imposed on) the process through which geographers continually re-create the intellectual structure of their discipline. Thus, each chapter acts as a proxy for one

TABLE II—SOME GENERAL CHARACTERISTICS OF *GEOGRAPHY IN AMERICA*^a

PART	CHARACTERISTIC		
	Number of Chapters in the Part	Number of Names Mentioned in the Part	Average Number of Names Mentioned per Chapter
I	5	285	57
II	11	1,078	98
III	6	500	83
IV	4	279	70
V	8	378	47
VI	9	645	72
VII	4	259	65

Source: Gaile and Willmott 2003.
^a “Names” refers to those shared by at least two of chapters 2–48, and all numbers are rounded to the nearest integer. See Table I for part and chapter titles.

subdiscipline. Because the chapter authors are practitioners of their subdiscipline and chose which names to mention or not to mention, the number of names shared among pairs of chapters is a proxy measure of the degree of intellectual similarity and connectivity of those chapter pairs.

The structure of the index of names of *Geography in America* (2003, 769–794) thereby acts as a proxy for disciplinary structure that combines the advantages of using AAG specialty-group rosters with the advantages of using the SCI and SSCI while avoiding some of their limitations. Like the specialty-group rosters, the index of names for a collection of chapters written by representatives of those specialty groups must necessarily approach the spectrum of research interests of the AAG membership itself and, therefore, the structure of the index serves as a good proxy for the comprehensive structure of the discipline. Unlike the specialty-group rosters, the index of names also reveals intellectual connections to non-AAG members, both geographers and others, such as Edward Said and Paul Krugman, who have influenced geography and appear in the name index. Also unlike the rosters, but like the citation indices, the index of names is a proxy for actual participation in the discipline’s intellectual structure through carrying out and publishing research, not merely of intent to participate by joining a specialty group. Like the citation indexes, author bias might cause overcitation or undercitation of particular names, but the size of the database neutralizes such bias; the 134 chapter authors and sev-

enty-five manuscript reviewers represent some 3.2 percent of the AAG membership in the year 2000, assuming no overlap in the two groups, and refer to some 8,500 publications, again assuming no overlap (Gaile and Willmott 2003, vii, xvii–xxi; Johnston 2004, 1004; Pandit 2004, 18). Unlike the citation indices, however, the index of names includes a broader range of types of participation in the discipline, listing not just citations in SCI and SSCI journals but also the authors of any article, chapter, book, abstract, presentation, or report that the chapter authors deemed to have contributed to their subdiscipline during, mainly, the 1990s. And that characteristic makes the index of names a better proxy for recent intellectual structure than the SCI and the SSCI: The practitioners of each subdiscipline chose to include a name in their chapter; we did not subjectively assign authors or publications to subdisciplinary categories in order to analyze the data. Thus the MDS analysis reveals structural attributes of the database rather than imposing them on it.

In the first stage of their analysis the graduate students converted the index of names into a matrix of the forty-seven chapters in order to display the number of names shared by each pair of chapters. Data preparation consisted of testing for and correcting several types of inaccuracy: correcting the table of contents, which lists erroneous page numbers for several chapters; testing the page numbers in the index for accuracy using a randomly selected sample of names; aggregating people listed under multiple names (for example, “N. Lam” and “N. S.-N. Lam”); disaggregating multiple people listed under the same name (for example, “M. Brown”); and eliminating names not directly involved in creating disciplinary intellectual structure (for example, “O. bin Laden” and “G. W. Bush”). Some data issues deserve extended comment. One type of issue ideally should be corrected, but doing so would involve a great deal of time and, according to our tests, would not significantly alter the MDS results. For example, for publications with more than two authors, only the first appears in citations and thus in the name index; the others are subsumed under “et al.” Another type of issue involves aspects of the database that some may argue require correction but in fact reflect disciplinary intellectual structure and should be left as is. For example, several chapters mention Gary Gaile and Cort Willmott not only in relation to their research in various subdisciplines but as the editors of their 1989 *Geography in America*, arguably inflating the similarity of those chapters; yet both *Geography in America* volumes undeniably reflect and impact the discipline’s intellectual structure, so all mentions of those names should be included in the analysis.

After addressing such raw-data issues, the students created a spreadsheet matrix of the number of names shared between chapter pairs. The spreadsheet assigned each of nearly 4,400 names to the chapters corresponding to the page numbers associated with that name in the index. The spreadsheet also reduced the data to a binary in which names had a value of 0 or 1 in each of 48 columns corresponding to the volume’s chapters. Reduction to a binary value eliminates the inflation of similarity due to multiple mentions of a single name in two chapters. Otherwise, two chapters in each of which a single name is mentioned on five different pages would

seem to have the same degree of similarity as do two chapters in which the same five names are mentioned only once. In other words, this analysis assumes that the number of individuals doing work significant to two subdisciplines best reflects the intellectual similarity of those two subdisciplines, irrespective of how many pages in each chapter contain the name of a given individual. Taking that approach prevents biases rooted in the very different writing and citation modes of subdisciplines that span the academy from the humanities to the natural sciences. As in Goodchild and Janelle's (1988) analysis, each individual can add a maximum of 1 to the cell in the matrix that represents the degree of similarity for the associated pair of subdisciplines. But unlike that earlier analysis, each name indexed in *Geography in America* represents an active intellectual connection between a pair of subdisciplines, not just a cross-membership in the associated specialty groups. After deleting the column of cells corresponding to chapter 1—the editorial introduction—the names that appear in only one chapter were eliminated because they do not create interchapter connectivity. Thus, in the following analysis “names” always refers to names shared by at least two of chapters 2–48. The final spreadsheet, containing binary values for the 1,201 names that remained, produced the sums that form the 47×47 matrix of the number of named practitioners shared by each pair of chapters.

The graduate students then used MDS to generate a two-dimensional representation of the structure of that matrix (Figure 1). As Gatrell and Smith (1984) and Goodchild and Janelle (1988) demonstrated, MDS reveals broad features of the structure of such matrices by using nonmetric multidimensional scaling to iteratively generate a two-dimensional solution (Golledge and Rushton 1972). Chapters that share many named practitioners appear relatively closer together in the resulting representation than do those that share few or no names. Clusters of chapters therefore indicate strongly connected subdisciplines that share many of the same practitioners. Using that representation, the class turned in a report at the end of the fall 2004 semester that answered the question: What are the interrelationships of geography's subdisciplines? That report still suffered from several problems involving data, analysis, interpretation, and presentation, but four of the doctoral students volunteered to resolve those outstanding issues in order to submit the results for publication.

A REPRESENTATION OF INTELLECTUAL STRUCTURE

Despite unavoidable distortion caused by reducing the relationships among the forty-seven chapters to two dimensions, the representation has a stress index of only 0.001 and therefore allows accurate visualization of the gross intellectual structure of the discipline that will resonate with many geographers. More nuanced understanding of the relationship of any one chapter to the other forty-six chapters, though, requires complementing visual assessment of the representation with cell-by-cell examination of the matrix (Goodchild and Janelle 1988).¹

Certainly the internal structures of physical and human geography become somewhat apparent, such as the greater similarity of geomorphology to biogeog-

FIG. 1—Two-dimensional, nonmetric representation of the similarity among chapters of *Geography in America at the Dawn of the 21st Century*, based on multidimensional scaling of its name index. Chapters, each one representing an AAG specialty group and thereby a geographical subdiscipline, that share many named practitioners appear relatively closer together than do those that share few or no named practitioners. Highly connected subdisciplines therefore tend to form clusters. The zoom box at lower left enlarges the tightly packed center of the diagram. *Source:* Gaile and Willmott 2003. (Diagram by Clifford Duplechin, Louisiana State University, Department of Geography and Anthropology)

raphy relative to climate; the greater similarity of urban and political geography relative to historical geography; and the lack of similarity between economic and cultural geography. Our presentation of results, however, focuses on the broader structural pattern, particularly on the relationship between human and physical geography.

A cluster of subdisciplines commonly labeled “physical geography” stands out in the bottom right-hand quadrant: biogeography, climate, cryosphere, and geomorphology. All four appear in the “Environmental Dynamics” part of *Geography in America*. Mountain geography, the final chapter in that part, appears on the upper margin of that cluster. Three environmental subdisciplines—HD (human dimensions of global change), water, and hazards—impinge on the lower and right edges of the physical cluster.

Because of their number, the many human-geography subdisciplines form a much more dispersed grouping that is largely left of center but spills over into the top right-hand quadrant. It includes the fourteen chapters by the American ethnic, American Indian, cultural, economic, GPOW (geographical perspectives on women), historical, rights, political, religion, rural, sexuality, socialist, urban, and values subdisciplines. Some, such as American ethnic and American Indian, form highly similar pairs with relatively weak connections to all but a few other human subdisciplines, in this case cultural and historical. Others, such as urban and cultural, share many named practitioners with the majority of other human subdisciplines, supporting Smith’s (2003, 21) finding regarding the eclectic affiliations of cultural geographers. Together those fourteen subdisciplines form a grouping concerned with understanding the basic processes of what Gaile and Willmott (2003, ix) call “human/society dynamics,” although the group revealed by the MDS differs from the chapters included under that rubric in *Geography in America*. Of the fourteen chapters grouped as human on the basis of Figure 1, seven appear in parts of *Geography in America* other than “Human/Society Dynamics”: American ethnic and American Indian in “Regional Geography”; GPOW, rights, religion, and values in “Values, Rights, and Justice”; and rural in “Environment/Society Dynamics.” Conversely, four chapters that do appear in “Human/Society Dynamics” in *Geography in America* do not group as human subdisciplines in Figure 1: CAPE (cultural and political ecology), perception, population, and transport.

The human and physical chapters share so few names that they do not overlap, but they do approach each other along a band of fifteen applied and environmental subdisciplines that bisects Figure 1 just below its belt line. The applied chapter marks the fulcrum of that band, but it stretches from CAPE, tourism, and agriculture on the left to medical, perception, and transport on the right. Arrayed between are aging, coastal, education, energy, HOG (history of geography), military, population, and mountain. This grouping therefore includes seven of the eight chapters—all except hazards—that appear in the “Geographers at Work” part of *Geography in America*, intended to designate subdisciplines with an applied orientation. It includes three of the six chapters in the “Environment/Society Dynamics” part, ex-

cluding HD, water, and rural because they appear either well below or above the applied/environmental band. And it includes two other environmental subdisciplines, using that term broadly to include nature/society and human-environment approaches: CAPE, from the "Human/Society Dynamics" part of *Geography in America*; and mountain, from the "Environmental Dynamics" part.

Two chapters in the "Geographic Methods" part of *Geography in America*, RS (remote sensing) and cartography, show up near the center of the predominately environmental and applied band, but the other two methods subdisciplines, GIS and quantitative, cluster together near the bottom, on the far right. RS is quite similar to both the GIS and the quantitative chapters, but moderate connectivity to several environmental and human subdisciplines, particularly hazards and rural, draws RS toward the center of the representation. Cartography, similarly, has strong connections to GIS and quantitative, but a high degree of similarity to the perception chapter draws cartography into the band of environmental and applied subdisciplines that bisects the representation.

The regional subdisciplines do not form a cluster because each has a fairly distinct pattern of connectivity to other chapters, dominated by human-geography subdisciplines. For example, the Russia chapter is highly similar to the European chapter, which, in turn, mainly connects to the economic, political, and socialist chapters. In contrast, the China chapter shares few names with any other regional chapter, even with Asia, which is itself mainly connected to the economic and rural subdisciplines. The Latin America and Africa chapters do not directly connect to each other much, but each shares many named practitioners with the CAPE chapter, thus being somewhat similar to an environmental subdiscipline. Africa appears above the band of environmental and applied subdisciplines, however, because it is most similar to human subdisciplines such as GPOW, whereas Latin America appears below that band because of its similarity to biogeography and, to some degree, HD. China's connections to chapters such as biogeography, perception, and transport draw it down into the band of environmental and applied subdisciplines. Arguably, most of the regional subdisciplines could simply be included in the human group. Latin America and China, albeit the latter less so, provide the exceptions because of connections to physical and environmental subdisciplines.

Although each reader may group the subdisciplines somewhat differently, the overall configuration of Figure 1 does not change and provides a revealing glimpse into the recent intellectual structure of the discipline. The graduate students, by generating this representation of the similarities and connections among their varied subdisciplines, actively engaged in learning how to conduct original research: from initial conceptualization of variables and relationships, to gathering and analyzing data, to interpreting results, to presenting findings. They generated a representation that helped them to better understand the relationship between their own particular subdisciplines and geography as a whole and, through this article, helps geographers in general to adjudicate among the competing models of the relationship between human and physical geography.

ENVIRONMENTAL AND APPLIED BRIDGES

The representation verifies the most basic feature of the existing models of disciplinary structure: human and physical geography form two distinct intellectual cores (Johnston 1983a; Stoddart 1987; Turner 2002). The human and physical groups in Figure 1 share so few names that all of the human chapters appear above the band of environmental and applied chapters; all of the physical ones, below it. The degree of isolation suggests a cause as foundational as modernism’s epistemological separation of nature from society (Sluyter 2002, 227–230).

Figure 1 does not support models in which methods and/or regional subdisciplines provide significant connectivity, minimal as it may be, between human and physical geography (Pattison 1964; Goodchild and Janelle 1988; Bodman 1991; NRC 1997, 28–29; Gaile and Willmott 2003, 8, 11). Of the regional subdisciplines, only Latin America is significantly similar to both some human and some physical subdisciplines and thereby connects

those two cores. Most regional chapters are highly dissimilar to environmental, let alone physical, chapters. And far from bridging human and physical geography, the methods subdisciplines are generally so dissimilar to either that they could be in the process of forming a third distinct disciplinary core that shares few practitioners with the other two cores—except, to some degree, quantitative with climate and RS with rural and biogeography.

Conversely, the representation reveals that the role of environmental and applied subdisciplines in connecting the human and physical, as well as the emerging methods, cores seems to have increased markedly since Pattison’s 1964 assessment and even since Johnston’s 1983 analysis. That finding partially confirms the model in the NRC report (1997, 28–29). Among many such connections involving applied and environmental subdisciplines, transport connects the methods and human cores. CAPE, mountain, and coastal bridge the human-physical gap. And HD provides connectivity between the physical core and methods. In corroboration, at least half of the eight practitioners whom nine or more chapters name have conducted environmental research, albeit under various rubrics such as human-environment, nature/society, cultural ecology, or political ecology (Table III). Except for David Harvey (1969, 1973), none of the eight has any association with methods subdisciplines, and Harvey’s association largely ended in the 1970s.

TABLE III—THE TOP THREE RANKS OF PRACTITIONERS, AS MEASURED BY THE NUMBER OF CHAPTERS IN GEOGRAPHY IN AMERICA IN WHICH EACH PRACTITIONER IS NAMED

NAME	NUMBER OF CHAPTERS	RANK
Richard Peet	13	1
Neil Smith	11	2
Karl Butzer	9	3
Gary Gaile	9	3
David Harvey	9	3
Carl Sauer	9	3
Andrew Sluyter	9	3
Michael Watts	9	3

Source: Gaile and Willmott 2003.

CORES AND BRIDGES

Such a representation can provide no more than a momentary glimpse into the historical process through which geographers continuously restructure their discipline. But, at the same time, such representations are an essential part of that process because they test conjectural models against data and thereby ground debate about the future of the discipline.

Like the results of analyses of other databases, such as AAG specialty-group rosters and the SCI and SSCI some two decades ago, the representation of the intellectual structure of the discipline inherent in the names indexed in the 2003 *Geography in America* reveals that human and physical geography have created highly dissimilar, largely unconnected intellectual cores. But the representation of the name index also reveals something more: The current minimal connectivity between human and physical geography operates mainly not through methods or regional subdisciplines but through environmental and, to a more limited degree, applied subdisciplines. That pattern seems to signal both an increase in the clustering of methods subdisciplines into a distinct third core and the growing role of environmental and applied subdisciplines in bridging all three cores. The recent shift in disciplinary resources from human to methods and environmental subdisciplines seems to corroborate that conclusion (Bierly and Gatrell 2004, 340). The limited scope of this study cannot address whether that pattern indicates the coming emergence of an entirely new environmental (or nature/society) core, but that possibility seems unlikely for both institutional and epistemological reasons (Turner 2002; Sluyter 2002, 227–230).

The graduate students in the 2004 incoming class who performed the analysis have already become an active part of the process through which geographers continually re-create their discipline's cores and the bridges among them. The students, like those in many other introductory graduate classes, learned how to situate themselves within the discipline's existing intellectual structure through reading, discussing, and synthesizing in term papers what others had already written about it; for example, the authors of the chapters in the 2003 *Geography in America* and those of the NRC's 1997 *Rediscovering Geography*. But the class also directly and collaboratively engaged data relevant to understanding disciplinary intellectual structure in order to create knowledge about it themselves, thus achieving deeper understanding than is possible through reading, discussing, and writing alone (Healey and Roberts 2004).

The data matrix the 2004 graduate class created has the potential to yield further insights. The graduate students in subsequent versions of the class could use it to carry out a linkage analysis to reveal chains of connections among subdisciplines, perhaps particularly useful for distinguishing differences in the ways in which specific environmental subdisciplines bridge specific human and physical subdisciplines. A focus on the internal structure of just one core would allow more detailed analysis of its subdisciplinary relationships, such as those within the possibly emerging methods core. Similarly, analysis centered on a single subdiscipline would allow

more nuanced understanding of its relationships to all other subdisciplines. Comparison with similar data from the 1989 *Geography in America* volume, and perhaps the 1954 *American Geography: Inventory and Prospect*, would develop a temporal dimension. Another potentially fruitful comparison could be with efforts to synthesize the discipline in the United Kingdom (see, for example, Johnston and Williams 2004; Batterbury 2005; Sheppard 2006, 120). A broader content analysis of selected chapters could reveal common research interests—whether directed at particular phenomena, methods, or regions—among subdisciplines with distinct groups of practitioners who do not overlap and do not engage one another's literatures. A comparison of alternative methods of measuring the similarity of chapter pairs would provide insights into the limitations of such quantitative analyses. And qualitative analysis, whether textual or based on interviews with the actors who contribute to the ongoing re-creation of the discipline, would address some of the shortcomings of a purely quantitative approach, reveal the traces of agency in disciplinary structure, and provide a basis for prediction.

NOTE

1. Figure 1 may tempt readers to infer detailed relationships among particular pairs of chapters. But although the diagram accurately represents the gross structure of the discipline, it contains unavoidable distortions: Detailed inferences about particular chapter pairs overreach the precision of the method and must remain more speculative than definite. Cell-by-cell examination of the matrix provides a crucial complement to visual analysis of the figure and can reveal the relationship between any single chapter and any other. Sluyter has completed such subdiscipline-centered analyses for historical and Latin Americanist geography and will make the matrix available to anyone who wishes to do so for other subdisciplines.

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