Spatial Levels in Cultural Organization:
An Empirical Study[1]

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INTRODUCTION

Interpreting comparative observations from diverse world cultures poses the dilemma of how to unfold the wide variety of functional and historical processes observed in cultural systems. Do correlations among cultural variables represent functional relations or historical adhesions? Some elements are acquired through independent invention (including functional adaptation), others through common origin (through migration, replication of like units) or diffusion (borrowing between units). Diverse origins may indicate differing functions or explanations for cultural phenomena, but functions also change in time and may require different explanations under the selective pressures of a different historical period. Similar institutions among cultures at one point in time may reflect convergent adaptation and historical interaction rather than commonality of origin.

Observations such as these were marshalled nearly a century ago by Boas (1896) as a critique of the kinds of overgeneralizations that might result from faulty assumptions in comparative research about the meaning of cultural correlations. They are just as relevant today in the debate over the validity of different kinds of comparison. The revival of comparative anthropology in the past 50 years, however, has offered a host of approaches to separating the different kinds of cultural processes and explanations. Driver (1956), for example, pioneered in examining the historical and spatial patterns of cultural similarities as well as functional

hypotheses as a more integrated approach to the testing of theory, at once functional, evolutionary, and historical. Naroll (1970) and others proposed a series of procedures to help identify the functional or "independent invention" component of cross-cultural correlation given evidence about the magnitude of historical effects, and tried to conceptualize models for how the two broad types of processes - historical and functional - are related.

Suppose that there are multiple processes in cultural systems that work at different spatial levels and time scales.[2] Is it necessary to abandon the comparative approach in order to identify and understand multi-level phenomenon in explaining cultural phenomena? While one can take a historical approach, a systems approach, or a particularistic approach to the embedding of culture in different epistemic levels, one can also utilize the comparative data base to investigate such questions. To do so, one approach is to formulate theories about the differing levels in the spatial organization of cultural systems, and look to comparative data to ascertain the empirical patterns of spatial organization in culture. Another parallel approach is to specify the broad phylogenetic affinities among the cultural entities in a comparative study, and look to how cultural similarities are organized phylogenetically.

The present article adopts the spatial perspective on the patterns of similarity and differences between culture-bearing entities, using a measure of spatial autocorrelation, the Moran coefficient (Moran 1950). An overall index of spatial clustering in cultural patterns is estimated from the application of spatial autocorrelation statistics to cross-cultural data. Autocorrelation - the measure of similarity among related units - has a direct relevance to comparative research in that it has profound methodological implications for testing cross-cultural hypotheses that depend on measuring correlation between variables. Even with small samples (e.g., of $N=40$), levels of autocorrelation of .40 and above are sufficient to cause serious underestimate, by orders of magnitude (e.g., at half or less of the true value) of sample variance, standard errors, and confidence limits (Dow, Burton and White 1982), both for sample means and estimates of correlation or regression coefficients.

Leaving methodological issues aside, at least until results of the study on levels of autocorrelation are presented, the spatial organization of culture is necessarily a major theoretical issue in anthropology if there are multiple processes in cultural systems that work at different spatial levels and time scales.

SPATIAL ORGANIZATION AS A THEORETICAL ISSUE

Anthropological theory distinguishes a number of different temporal processes in human cultural systems that operate at different but interpenetrating levels of spatial organization. Four major spatial scales and their temporal processes in human cultural systems can be briefly summarized:

1. Regional macro-cultures and civilizational networks, at multi-millenial time scales (2-9000 years), are affected by the rise and demise of co-traditions and civilizations which carry distinctive modes of plant and animal domestication, modes of production and reproduction, ideological systems and modes of social sanction, political conflict, decision-making, and ritual (especially those governing reproduction or social group membership), and regulation of sexuality (see Wilkinson 1987, Wolf 1982).

2. Co-traditions[3] and specific civilizations, comprised of transacting cultural entities in world regions, operating at culture-span time scales (200-1200 years), are impacted by the rise and demise of sociopolitical traditions carrying modes of trade or war (see Iberall and White 1988).

3. Cultural traditions, at life-span time scales (at which individuals are born into and diffuse into cultures), are affected by the passing of individual habit systems as variable adaptations to regional ecosystems.

4.   Local cultural phases, at generational time scales, are impacted by the novelty of each generation's response (adaptation, invention) to changing conditions.

These levels are linked in two ways. From the bottom "up," units at a lower level may (but do not necessarily) aggregate into units at a higher level. Specifically, at each level, from the bottom: (4) the specific modes of adaptation of local level cultural systems typically "aggregate" into larger cultural types within ecological regions; (3) culture types typically "aggregate" into co-traditions via the linking mechanisms of trade networks, local level conflict, migration, etc.; (2) co-traditions typically "aggregate" into civilizational networks. From the top "down," units at a higher level impact on those at lower levels and evoke responses. Specifically, at each level, from the top: (1) civilizations intrude at every level on other cultural levels via long-distance trade, state level warfare, conquest, colonization, proselytization and cultural exchange; (2) co-traditions do the same at more proximal levels, and (3) culture types in ecological regions impact on other types in the same region.

It is important at each level that while there is some degree of (a) sharing of traits that characterize cultural units there is a second and separate aspect of (b) sharing having to do with interaction between these units, their expansion, or the encapsulation of one within another. Lessing (1961: 93) made the point nicely:

> "…such concepts as diffusion and borrowing, and the contact to which they refer, have a fundamental implication which cannot be ignored: that any one social aggregate - group, settlement, community, tribe - is involved with others, than an interdependent influence of social aggregates upon one another is virtually universal."

The two aspects of within unit characteristics and between unit interaction, operating at each level, are distinguished under subheadings (a) and (b) below.

1a   Co-adaptation and co-invention of distinctive plant and animal domesticates, interlinked modes of production and reproduction, linked ideological and religious systems, and concomitant modes of social sanction bring about the sharing of certain macro-regional or macro cultural features, often at the subcontinental level, between otherwise culturally heterogeneous societies.

1b   Through political conflicts and interactive geopolitical decision-making between such units, and the consequent need for internal political regulation within them, especially via rituals that govern reproduction or group membership and the regulation of sexuality, civilizational networks with multiple macro-regions may come to share distinctive modes of behavior in these "regulatory" domains although they are otherwise culturally heterogeneous.

2a   More global modes of trade, conflict and migration (or other interactions that become institutionalized) structure regional interaction between local societies that are consequently linked into co-traditions in otherwise culturally heterogeneous regions.

2b   Modes of trade and conflict may be more widely imposed in some historical periods by conquest, colonization, or the expansion of empires.

3a   Variable but related adaptations in relation to specific regional ecosystems link local societies into cultural traditions with more narrowly shared features.

3b   As new adaptations are achieved, either through specific regional adaptation, or more general adaptability through more flexible ways of relating to the environment, two processes of wider sharing ensue: (1) adaptive radiation may spread a specific adaptation to other regions with ecologies suited to the adaptation, or (2) intersocietal linkages such as localized modes of trade or war may spread the more generally adaptive features.

4a   Independent adaptation and invention in response to local conditions leads to local cultural phases shared within larger regional ecosystems.

4b   (1) Specific features of subsistence and community organization will diffuse through the adjacent ecological "niche" where they are adaptive. (2) Since generalized actions of larger systems may be

taken independent of spatial localization, local responses to outside linkages will be relatively independent of spatial neighbors.

The relevance of this discussion for the organization of cultural sharing is that we might expect certain types of variables to reflect differences as to the level or scale (1-4) of cultural systems, other clusters of variables may reflect differences of domain in terms of the within culture/between cultures distinction (a/b) operating at each level.

SPECIFYING THE THEORY

The analysis of spatial autocorrelation viewed in terms of level and interaction may be helpful in organizing hypotheses and theories about the different kinds of cultural content shared at different levels of spatial clustering. We can hypothesize that *(1) higher levels or more widely distributed patterns of spatial similarity should show higher coefficients of spatial clustering;* and *(2) what is shared at each level will tend to match the specific evolutionary "problematics" of that level.* Although the next section of this paper will try to specify the problematics of each level in more detail, it is only a loose fit that is expected between form (levels of spatial clustering) and content (specific clusters of variables by domain).

A general sense of the predictions about problematics of cultural systems at different levels is given in Table 1. The key to understanding how to make sense of spatial levels in culture is the insight of systems theory (Iberall and Wilkinson 1987) that larger groupings emergent from interactions at a lower level become "units" at the next higher level. Thus at level 4 we have "local cultural phases" (4a) that interact (4b) to form the "cultural traditions" of level 3. At level 3 the "cultural traditions" (3a) interact (3b) to form the "co-traditions" of level 2. At level 2 the "co-traditions" (2a) interact (2b) to form the "world regions" of level 1. The links between levels are explicit developments of higher-order units via interaction of lower ones.

Table 1: Predictions of the Theory

"Units" (a) and Interactions (b)	Evolutionary "Problematics"
1. **Strategic Behavior and Politics:** b world networks a "higher order co-traditions ("world regions" as units)	WS contact agents (incl.ethnographers) internal political regulation: e.g., sexuality, kinship, reproductive ritual
2. **Mode of Production, Reproduction, Sanction and Ideology:** b higher order co-traditions (world regions) a local "co-traditions relationally linked units	conquest, colonization, WS positions, state level war, relocation crops, explanations, alliances, division of labor: crafts & animals
3. **Ecological Adaptation:** b local co-traditions a "cultural traditions"	local war, trade climate, language
4. **Independent Local Distribution:** b cultural traditions a "local cultural phases"	subsistence, community local trade, complexity

Emergent units thus appear in quotes at the higher levels. Linkages between levels in emergent processes also relate to the problematics of each level. Thus, for example, world regions that may emerge at level 2b from conquest and colonization, when looked at as "world regional units" at level 1a, have the problematic of internal political regulation, which often involve regulating the rituals that govern reproduction, sexuality, and group membership. The problematics of Table 1 are a shorthand for the discussion of levels of spatial organization below.

METHODS OF THE PRESENT STUDY

The Moran coefficient measures the extent to which point data are spatially clustered (Moran 1950). Spatial clustering means that points resemble their neighbors. Such similarities are typically assumed to fall off inversely to the square of distance between the points. The distance "decay" process is like the diffusion of an oil droplet on a watery surface: the oil slick grows thinner proportionally to the area covered (with

area a function of distance squared). Other models for the spatial decay or underlying *diffusion process* can be envisioned, but this is the simplest and most standard measure used in geography, which deals with spatial distributions and clustering on the earth's surface (Ebdon 1985). The computational formula for the Moran coefficient requires only a set of points, their spatial coordinates, and a numeric variable that takes a single value at each point. The spatially weighted version of the Moran I coefficient is as follows:

$$I = \frac{N \sum_{i=1}^{N} \sum_{j=1}^{N} W_{ij} (X_i - \overline{X}) (X_j - \overline{X})}{\left(\sum_{i=1}^{N} \sum_{j=1}^{N} W_{ij} \right) \sum_{i=1}^{N} (X_i - \overline{X})^2}$$

(Ebdon 1985: 160, formula 7.28)

Trait data can be coded 0/1 for presence/absence, and ordinal or continuous variables are treated by transforming the data to differences from the median category or mean value. Such transformations are taken into account in the formula, and the computer program given in Ebdon (1985: 174-175) is simple to implement and quick to run on a personal computer. The program as implemented for the present study is part of the AUT-SPAT program for computing spatial autocorrelation matrices and coefficients (White 1989a).

Using the Moran coefficient on 1290 variables on which data have been published in World Cultures 4, the present study computes the degree of spatial clustering or autocorrelation for even-numbered societies in the Standard Cross-Cultural Sample (Murdock and White 1969). For this reduced sample size, this is a relatively quick operation using the MAPTAB program to retrieve data and the AUT-SPAT program to compute coefficients and save them to disk. Of the 1290 variables, nearly seventy were eliminated because extensive missing data reduced the number of cases below the level where the coefficient would yield reliable results; about forty variables were eliminated because they did

not vary sufficiently to have two or more numeric values each with three or more cases. Thus, of the original 1290 variables, 1178 were suitable for analysis. [The present results are preliminary in that not all of the 1178 variables were recoded into ordinal scales; the results are conservative, however, in that this lowers the extent of spatial clustering].

To analyze the pattern of results, the 1178 coefficients resulting from the analysis were grouped, first by the topic under which they occurred when coded by their authors (see bibliography of citations), and then by level of autocorrelation within each such topic, into about 120 categories. Average Moran coefficients were computed for each category, along with their standard error, and domains with high standard errors were broken into finer groups until each group had a reliable coefficient. *These categories can be recombined into more generic domains that cut across studies done by the authors of different codes, as will be done below when two or more categories are similar in substance as well as level of autocorrelation.*

RESULTS OF TESTING THE THEORY

Table 2 (appendix) provides the most general level of results of the spatial clustering test: domains which have both the level of spatial clustering and the type of substantive content loosely predicted by the theory of spatial levels. It is derived from Table 3 (appendix), which gives more specific results. Table 3 presents spatial clustering coefficients for sets of variables on topics from different studies, where the level of clustering is fairly uniform within the sets (if not, the sets were broken up at a previous step in the analysis).

Of the 1178 variables, 35% are moderate or strong (over .30) in spatial clustering; 26% are severe (over .50) or extreme (over .60). This is a very high degree of spatial autocorrelation for a substantial number of variables.

The first specific result to note in examining Tables 2 and 3 is that the highest degree of spatial clustering is for the date of ethnographic observation (Moran coefficient = .99). The "ethnographic present" has a temporal manifold that fits the theory of spatio-temporal clustering at the

highest, world-systems (WS) level. The space-time diffusion of ethnography itself follows the expansion of colonialization in the modern worldsystems/local cultures interface (White, Burton, Bradley and Moore 1989). Fieldwork quality (Rohner, Berg and Rohner 1982) also has high spatial clustering (.64). The next highest spatial clustering for a world system domain is for taxes and rents (.69). Missionization, while not measured here, is probably also highly spatially clustered.

The second result to note is the high degree of spatial clustering of a series of domains linked to internal political and sexual-reproductive regulation (see Yehudi Cohen 1969): political decision-making (Ross 1983, Tuden and Marshall 1972), harems and despots (Betzig 1986), reproductive rituals (Paige and Paige 1981), and sexuality (Frayser 1985, Broude and Greene 1976).

The assumption that stereotyped kinship behaviors regulate group membership would help to explain the surprising but consistent result of high spatial clustering of kin behaviors (Murdock 1971), parental behaviors (Rohner and Rohner 1981), the importance of kin for children (Rohner and Rohner 1982), and certain child training practices such as weaning, new foods, motor skills, autonomy, elimination control, non-maternal relations (Barry and Paxson 1971), non-parental caretakers (Rohner and Rohner 1982), and parental encouragement for control by public opinion (Barry, Josephson, Lauer and Marshall 1976). If the current theory of spatial levels is correct, this would be due not simply to the "diffusion" of kin behaviors, but to the linkage between political economy in regulating large-scale social systems and core kinship behaviors and child training practices that are central elements in socialization. There are, then, over 200 variables with extreme spatial clustering (Moran coefficient > .60) that fit the present theory of spatial levels in terms of links or potential links to large scale political economies.

The only variables with extreme spatial clustering that do not fit the theory of spatial organization advanced here are: human burden carrying and bodily mutilation (both are marginal at .60, and thus are classified with the next level), and division of labor in vegetal food collection, shellfishing, fowling, and hunting large game (Murdock and Provost

1973a). The explanation for clustering in the latter set of variables cannot be the marginality of food-getting activities with respect to the incursion of food-producing economies, since the distributions of these tasks themselves are not so strongly spatially clustered. It is only the sexual division of labor that is strongly spatially clustered in these activities.

An alternative theory of slower-scale ecological and evolutionary processes, not formulated here, is needed to deal with aboriginal foodcollecting societies. Large-scale ecological patterns are clearly the explanation for macro-regional spatial clustering in food collection (e.g., shellfishing is male in the Americas south of the Pacific Northwest, but tends to be female elsewhere; vegetal collection is more equal between males and females in tropical regions).

At the other extreme, agricultural potentials (Pryor 1986) do not cluster spatially (apart from extreme cold climates). The independent rise of food producing systems would be predicted from the independent distribution of agricultural potentials.

About half of the variables surveyed had no spatial autocorrelation (i.e., not significant, or Moran's coefficient < .10). Many of these are variables that clearly have their origin in relation to complex civilizations and worldsystems (cultural complexity, conquest of other societies, slavery, WS economic links), but these links are not spatially clustered. In these features (White, Burton, Bradley and Moore 1989), historical networks, markets, and transport systems override spatial constraints. Phylogenetic linkages between political or civilizational systems are needed in this case to study autocorrelation effects. Political organization (Tuden and Marshall 1972, Murdock 1957, 1961-71, Ross 1983, Whyte 1985) shows little or no tendency to spatial clustering, but state systems clearly are also often linked as secondary developments from civilizational networks. Similarly for agricultural origins (Pryor 1984, 1985, 1986), population densities (Murdock 1961-71), household division of labor (Whyte 1985), and formal schooling (Barry, Josephson, Lauer and Marshall 1977).

Aspects of local cultures that are easily and independently reinvented are also spatially unclustered. Among the unclustered items, these include: initiations and adolescent sexual behavior (Schlegel and Barry 1979, Barry and Schlegel 1984), ceremonialism and protectiveness towards children, sex of parental authority, sleeping proximities of parent to child, parental warmth (Rohner and Rohner 1981), responsibility training, and duration of childhood (Barry and Paxson 1971), types of marriage transactions (Murdock 1961-71, Schlegel and Eloul 1987), causes of divorce (Betzig 1989), normative nonmarital rape (Roz e-Koker 1987), and non-focal or rare kin-avoidance behaviors (Murdock 1971, White 1989).

Mild to moderate clustering, in theory, might be found in association with cultural traditions adapted at regional ecological levels. This seems consistent with the following. Very mild spatial clustering (.10-.15, even if significant) is found for settlement and community organization (Murdock and Wilson 1972), subsistence type, kin terms, succession to local office, inheritance, class and caste stratification, and type of dwelling (Murdock 1961-71, 1970, Murdock and Morrow 1970, and other studies). Minor (.15-.20) to moderate spatial clustering is found for climate zone (White, Whiting and Burton 1986), language family (Murdock 1961-71, Burton, White and Whiting 1986), inculcation of certain childhood traits (restraint, fortitude, aggression, competitiveness, trust, honesty; Barry, Josephson, Lauer and Marshall 1976), ceremonies for children (Barry and Paxson 1971) and gifts to children for approved behaviors (Barry, Josephson, Lauer and Marshall 1977), focal kin avoidances (White 1989 argues that these derive from marriage alliance systems), presence of domestic crafts (Murdock and Provost 1973a), magico-religious practitioners (Winkelman and White 1986), evil eye beliefs (Roberts 1976), polygyny (White 1988, and other studies), and a number of aspects of women's status (Whyte 1979).

Mild to moderate clustering is also found in commensurate co-tradition variables that link local societies: local level warfare (Wheeler 1974, White 1989), local middlemen and market mechanisms (Murdock and Morrow 1970), and neolithic subsistence food production innovations

such as domestic animals, fishing, and some types of gathering (Murdock and Provost 1973a). Some of these are features that might spread easily through adaptive radiation. Moderate clustering is also found in subsistence changes in response to world system linkages (Bradley, Moore, Burton and White 1988).

Strong but not extreme spatial clustering, in theory, should be found in major world regional patterns of long-term co-adaptation. This fits the level of spatial clustering found for crops and crop types (Murdock and Morrow 1970, Pryor 1985), division of labor in crafts and animal husbandry (Murdock and Provost 1973a), theories of illness (Murdock, Wilson, and Frederick 1978, Murdock 1980), verbal techniques with children (Barry, Josephson, Lauer and Marshall 1977), indulgence (Barry and Paxson 1971), husband-wife relationships (Broude and Greene 1983), marriage alliances (White 1989), and rape (Rozée-Koker 1987).

Strong clustering is also expected for many of the world-system variables. This fits the theory for world-system position, induced migration, relocation, depopulation, expanding frontiers, colonization, conquest, and local involvement in state level war (White, Burton, Bradley and Moore 1989).

In summary, the theory of distinct but interpenetrating spatial levels and processes fits remarkably well with the results of the comprehensive analysis of spatial clustering of cultural variables in the World Cultures Standard Sample database.

IMPLICATIONS FOR CROSS-CULTURAL RESEARCH

The extent of spatial autocorrelation (clustering) found in this survey of coded cross-cultural variables is quite high: 35% or more of the variables had moderate autocorrelation or stronger (over .30); 32% had

strong or more autocorrelation (over .40), 26% had severe or extreme autocorrelation (over .50), and 19% had extreme autocorrelation (over .60).

If cross-culturalists had to follow Murdock's (1949) advice to avoid the problem of non-independence of cases by dealing only with variables that are not clustered or autocorrelated, many of the more fruitful problems for comparative analysis would be eliminated. If the present study, dealing only with spatial autocorrelation, were enlarged to include phylogenetic and other types of autocorrelation, the number of topics in which the variables lack moderate to strong autocorrelation would shrink to a fraction of those that have been studied.

Fortunately, there are valid methodological solutions to autocorrelation problems in making statistical estimates from cross-cultural samples. The AUT-COR program (Reitz and Dow 1989) for multiple regression analysis is available through World Cultures electronic journal (see Dow, Burton, Reitz and White 1984).

Unfortunately, many recent studies have ignored the existence and problem of autocorrelation in cross-cultural research. When these studies are combined with earlier studies that ignored "Galton's" problem, there are hundreds of studies with findings subject to probable overestimates of significance. Consequently, there is a need to retest all findings for hypotheses tested with variables with high spatial clustering.

Four reasons why researchers have continued to ignore the autocorrelation problem can be traced to the following logical errors:

(1) Since autocorrelation does not directly bias estimates of means or correlations, many, like Ember (1971), have ignored the fact that autocorrelation does affect sampling bias in estimates of variance. The effect on estimates of variance is similar to the design effect of cluster sampling (White 1989b), and deflates estimates of true variances, standard errors, confidence limits, and replication, while inflating estimates of significance.

(2) The problem of non-independence of cases is often confused with randomization in sampling design. Even worse, some confuse random sampling with randomization in experimental treatments, and assume that random sampling not only eliminates Galton's problem but eliminates rival or lurking "third factor" hypotheses as well!

(3) Many researchers think sample size affects the non-independence problem and can reduce the extent of autocorrelation. As a test if this notion, I ran Moran's autocorrelation coefficients for samples of size 186, 93, 45, and 22 for the first 100 variables in the present study, and found virtually no reduction in the autocorrelation measures! Autocorrelation is holographic, and does not diminish with sample size until the sample is so small (e.g., $N=10$) as to eliminate both spatial pattern and the possibility of statistical analysis (on this point see Murdock and White 1969).

(4) Finally, some try to dismiss the problem on the argument that if strong spatial clustering is found only in 1/3 of the variables, then the chance of both variables in a hypotheses have strong autocorrelation is compounded (1/3 times 1/3 = 1/9th of all pairs of variables). However, since autocorrelation inflates significance, "significant" results such as are reported in the literature will reflect spurious effects of autocorrelation in a much higher proporition than 1/9th of the findings. An upper estimate is that half of the findings reported in the cross-cultural literature could be unreliable just on the basis of spatial autocorrelation alone!

Problems of statistical underestimation caused by autocorrelation can result from spatial clustering of either dependent variables or independent variables, or both. In my own recent studies of autocorrelation effects in testing hypotheses about the sexual division of labor (Burton and White 1984) and polygyny (White and Burton 1988), autocorrelation was found to be a problem at various stages of hypothesis testing, even though the dependent variables in these studies - division of labor in agriculture and polygyny - had only mild levels of spatial clustering (e.g. Moran coeffi-

cients of .20 for polygyny). If autocorrelation was already a problem in these studies, it is likely to be much more of a problem with at least 1/3 of the substantive variables available for study.

CONCLUSION

This article has shown that spatial autocorrelation can be studied as a substantive topic in its own right, and can contribute to the formulation of more encompassing theories about the organization of cultural systems. Specifically, it has been established that the local cultures studied by ethnographers, and coded in the Standard Cross-Cultural Sample (Murdock and White 1969) display high proportions of sharing in characteristics that have to do with (1) world-regional systems of co-adaptation, and political-economic interactions at a larger or world-system scale; (2) subregional co-traditions with intersocietal linkages, including localized trade, war, and migration, and capable of expansion over larger areas via conquest, colonization and empire; (3) co-ecological subregions of adaptation, which are sometimes exported through adaptive radiation or through localized trade, war, and migration. At these three levels at which cultural characteristics are shared above the level of the local society, differences in the scale or extent of spatial clustering of variables support the hypothesis that clusters of variables relating to the problematics of these three levels tend to display patterns of spatial sharing differing in spatial scale at each levels. At level (1) we see widestread sharing of "problematic" variables that tend to be those most affected by world-system contact agents (including the ethnographer) and problems of internal sociopolitical regulation (including sexuality, reproductive rituals and kinship behaviors). At level (2) the shared variables, at a lesser spatial scale, tend to be those of world-system operations (conquest, colonization; economic positions, state level war, enforced relocation) and co-adaptive traditions such as regional crop types, magico-religious beliefs, alliance systems, and sexual division of labor in crafts and animal husbandry. At level (3) the shared variables, again at a lower scale, tend to be local systems of warfare and trade, subsistence changes in response to world-system linkages, and variables

related to language families and specific types of ecological adaptation. Finally, although about half of the 1290 variables presently coded for the standard sample are spatially unclustered, many of these reflect non-localized effects of larger world-system processes (conquest, cultural complexity and states, slavery, world-system economic linkages). Variables like agricultural potentials, that are independent of world system effects, and not spatially clustered, are in the minority, and those that represent easily reinvented local adaptations (e.g., kin terms, or causes of divorce) only a fraction of the total range of variables.

Given the strong empirical evidence for several interpenetrating higher levels of spatial organization in cultural systems, and improvement in methods of studing spatial organization, the way is open for comparative anthropology both to improve of hypotheses testing generally, by taking spatial processes into account, and to strengthen its theories about socio-cultural processes by giving greater attention to spatial and temporal scalings.

FOOTNOTES

1 This paper is the fifth in a series of studies on spatial autocorrelation begun with NSF funding to White and Burton. The first (White, Burton and Dow 1981) showed the applicability of spatial and network autocorrelation to solution of Galton's problem is testing cross-cultural hypotheses, and exemplified a case of autocorrelation residuals. The second (Dow, Burton and White 1982) provided simulation results that showed spatial autocorrelation to be a pervasive problem, even with small samples, that led to massive underestimation of sample variances, standard errors and confidence limits, hence to overestimation of statistical significance. The third (Dow, White and Burton 1982) showed further applicability of these models to hypothesis testing. The fourth (Dow, Burton, Reitz and White 1984) provided computer programs that solved regression problems with autocorrelation models more quickly by using approximation methods. The earlier research on which this study is based was supported by NSF grants BNS-80-23904, 83-04782 and 85-0785 to Douglas R. White and Michael Burton.

2 See for example Alexander Spoehr (1947), Harold Driver (1957), Alexander Lesser (1961), Eric Wolf (1982) on larger processual views of evolutionary history.

3 My use of the term co-tradition may be more inclusive sense than that of archaeologists, but I share the meaning that "the emphasis on the word 'co-' is on linkage of whole [units], each with its own history and persistent [patterns], and on the area in which this linkage takes place" (Willey and Phillips 1958). In my usage, the Cheyenne-Arapaho and related Northern Plains Indians would be a cultural tradition, linked in a co-tradition area to other Plains societies, with more global interaction between co-tradition areas in Northern Mexico and the Southwest, the Great Basin, and the Praries.

4 1240 variables plus 50 variables coded in two independent ways, one for sexual division of labor in activities, the other for presence or absence of these activities. World Cultures is the electronic journal of comparative research.

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APPENDIX

Table 2: Results of Spatial Clustering Test, Categorized by Domain

I. Strategic Behavior and Politics:
B. Dependent Aspects: WORLD NETWORKS
   The "Ethnographic Present"
   Changes in Land Tenure and Taxes
   ? Missionaries (not coded)
A. Autonomous Aspects: GLOBAL CO-TRADITIONS (WORLD REGIONS)
   Political Decision-Making
   Harems and Despots
   Reproductive Rituals
   Sexuality
   Kin Behaviors
   Parental Behaviors: Warmth, Hostility, Control
   Importance of Kin for Children
   Division of Labor in Hunting and Gathering

2. **Mode of Production, Reproduction, Sanction and Ideology:**
B. Dependent Aspects: GLOBAL CO-TRADITIONS (WORLD REGIONS)
   WS Position
   WS Migration
   WS Relocation
   WS Depopulation
   WS Frontier
   WS Colonization
   WS Conquest
   State Level War
A. Autonomous Aspects: LOCAL CO-TRADITIONS
   Crops
   Division of Labor in Crafts and Animal Husbandry
   Theories of Illness
   Verbal Techniques with Children
   Indulgence
   Husband-wife Relationships
   Marriage Alliances
   Rape

3. **Ecological Adaptation:**
B. Dependent Aspects: LOCAL CO-TRADITIONS
   (Adaptive Radiation) Domestic Animals, Gathering, Fishing
   Local Warfare
   Local Middlemen and Market Mechanisms
   WS Subsistence Change
A. Autonomous Aspects: CULTURE AREAS
   Restraint, aggression, competitiveness, fortitude, trust, honesty
   Ceremonies and gifts for children
   Focal Avoidances (from marriage alliance systems)
   Climate Zone
   Language
   Agricultural Potentials and Subsistence
   Settlement and Community Organization
   Presence of Domestic Crafts
   Magico-Religious Practitioners, Beliefs (e.g., Evil Eye)

   Polygyny
   Aspects of Women's Status ? (should be broken down)

4. **Independently distributed or invented:**
B. Dependent Aspects: WORLD NETWORKS, CO-TRADITIONS
   (Networks and Markets operating "independently" of spatial constraints)
   Cultural Complexity
   Conquest
   Slavery
   WS Economic Links
   States and Political Organization
A. Autonomous Aspects: LOCAL CULTURES
   Household Division of Labor
   Warmth and Responsibility Training
   Normative Non-Marital Rape
   Causes of Divorce
   Kin Terms
   Rare Avoidances

Table 3: Results of Spatial Clustering Test, Categorized by Study-Topics

4a = = =586=50% = NO SIGNIFICANT SPATIAL AUTOCORRELATION

377 - 380	- .0178	Non-parental involvement in authority
293 - 293	- .0153	Duration of early childhood
1180 - 1187	- .0154	Normative non-marital Rape
798 - 801	.0021	Date and length of publication or topical coverage
1136 - 1177	.0112	Causes of Divorce
148 148	.0157	Division of Labor: Housebuilding
1006 - 1063	.0215	WS Linkages: economic
23	.0281	Sleeping proximity of parents to infant
1204 - 1218	.0302	Rare Avoidances

425 - 428	.0339	Guidance or formal schooling
1087 - 1089	.0360	Political Conquest of others
529 - 560	.0443	Initiations
147 147	.0473	Task: Boats
921 - 930	.0478	Agricultural Potentials
710 - 738	.0486	Women's Status Independent Variables
833 - 850	.0496	Economy, Political Organization, Descent
827 - 832	.0499	Adolescent Sexual Behavior
1094 - 1098	.0510	WS Adjustment: Population Recovery
917 - 920	.0519	Slavery
385 - 388	.0530	Sex of parental authority
1238 - 1240	.0535	Marriage Transactions
1122 - 1132	.0548	Agricultural Origins & States, Population
1102 - 1109	.0569	WS Adjustment: Migration or Relocation
35 - 37	.0592	Ceremonialism and protectiveness towards child
105 112	.0669	Task: Trap, Hunt, Agriculture
270 - 292	.0673	ETHNO-ATLAS Table d (except language)
81 - 93	.0680	Political organization
361 - 364	.0885	Non-parental child care
149 - 158	.0887	Cultural Complexity
337 - 356	.0948	Companions and residence for child (except sex of non-parent)
121 123	.0985	Division of Labor: Cook, Fuel
885 - 890	.0995	Female Contribution to Subsistence Scales

4b = = = = = = = = NO SIGNIFICANT SPATIAL AUTOCORRELATION

814 - 826	.1019	Sexual Division of Labor (Barry) split into imptc/sexdiv
61 - 80	.1022	Settlement and Community Organization
680 - 709	.1058	Women's Status Independent Variables
1115 - 1120	.1103	WS Adjustment: Pacification
1 - 22	.1113	Subsistence (except for food crops, middlemen)

1072 - 1076	.1114	WS Adjustment: Form of Tax Levies and Rents
200 - 231	.1164	ETHNO-ATLAS Table a
43 - 47	.1184	Age of covering genitals, weaning, motor skill development including 39
232 - 268	.1207	ETHNO-ATLAS TABLES b, c
637 - 643	.1214	Kin terms
854 - 859	.1216	Subsistence
122 124	.1276	Task: Mine, Lumber,
269	.1289	ETHNO-ATLAS TABLE d (LANGUAGE - REVISED)
409 - 420	.1295	Non-parental and parental education (except non-parental gender)
421 + 423	.1300	Sex of principal non-parental educators: boys
306 - 325	.1315	Self-reliance, achievmt, industry, responsibility, obedience
465 - 480	.1334	Permissiveness, affection, evaluation, incorporation
453 - 456	.1428	Corporal punishment
145 145	.1435	Task: Bonesetting

4b = = = = = = = 126 = 11% = = MINOR SPATIAL AUTOCORRELATION

854 857	.1576	Climate
879 - 884	.1631	Magico-Religious Practitioners (except priest)
576 - 636	.1711	Women's Status
860 - 878	.1736	Polygyny
134 136	.1804	Task: Leather, Cloth, Pots
127 132	.1813	Task: Spin, Loom, Smelt, Mat, Nets, Basket
104 109	.1901	Division of Labor: Fish, Trap
1188 - 1189	.1902	Evil Eye
179 - 199	.1909	Climate
851 - 853	.1985	Language

3a======= 50= 4%== MILD SPATIAL AUTOCORRELATION

143	143	.2009	Task: Launder
50 -	56	.2181	Devel. order of covering genitals, non-maternal caretakers
891 -	916	.2660	Warfare
99	104	.2672	Task: Collect, Fish
114	120	.2710	Task: Large Animals, Milk, Hides, Drink/Dairy
330 -	336	.2826	*Sexual restraint, trust, honesty*
457 -	464	.2852	Ceremonies and gifts for children

3b====== 51= 4%= MODERATE SPATIAL AUTOCORRELATION

1196 -	1198	.3066	Common Avoidances
110	113	.3533	Division of Labor: Plan, Tend, Harvest, Small Animals
2		.3636	Food acquisition - middlemen
884		.3685	Priests
365 -	376	.3759	Non-parental caretakers, and principal parental caretaker
381 -	384	.3767	Principal non-parental authority
23 -	60	.3773	Infancy and Early Childhood
326 -	329	.3954	Self-restraint
294 -	305	.3967	Fortitude, aggression, competitiveness
1078 -	1085	.3997	WS Linkages: Changes in Subsistence

2a======= 70= 6%== STRONG SPATIAL AUTOCORRELATION

353 -	360	.4373	Sex of caretakers in residence
1179 -	1181	.4383	Non-Normative and Marital Rape
644 -	656	.4447	Theories of Illness
429 -	432	.4505	Use of example
1107 -	1112	.4546	WS Linkages: State Level War, War *Stoppage, Turbulence*
122	147	.4862	Division of Labor: Mine, Lumber, Crafts
1100 -	1101	.4880	WS Linkages: Migration or Relocation

389 -	408	.4892	Disciplinarians; Sex of non-parental authority
1121 -	1121	.4911	WS Linkages: Depopulation
24 -	34	.4918	Infant contact, crying, pain, post-partum sex taboo

2b======= 77= 7%== SEVERE SPATIAL AUTOCORRELATION

1190 -	1195	.5023	Kin groups linked through Marriage
1113 -	1114	.5248	WS Linkages: Frontier
57 -	60	.5341	Indulgence
657 -	679	.5342	Female Power & Male Dominance
739 -	755	.5543	Husband-Wife Relationship
1090 -	1095	.5586	WS Linkages: Conquered or Colonized
114	120	.5747	Division of Labor: Large Animals, Milk, Hides, Drink/Dairy
1006		.5757	WS Economic Position
437 -	452	.5793	Lecturing, teasing, scolding, warning
4		.5934	Crops
422 +	424	.5982	Sex of principal non-parental educators: girls

1a===== 117=10%= EXTREME SPATIAL AUTOCORRELATION

144 +	146	.6037	Task: Burdens, .6148 Body Mutilation
1133 -	1135	.6175	Harems and Despotism
802 -	813	.6382	Fieldwork quality
99	106	.6464	Division of Labor: Collect, Hunt
52		.6417	Non-maternal relations, early childhood
38 -	42	.6430	New foods, severity of weaning, motor skills, autonomy, elimination excluding 39 - weaning
159 -	178	.6488	Sexual Practices & Attitudes
357 -	360	.6737	Sex of non-parent in residence
94 -	96	.6748	Secondary sources of political power
48 -	49	.6754	Autonomy and elimination control
931 -	985	.6856	Sexual Experience

1066 - 1071	.6866	WS Linkages: Changes in Land Tenure and Taxes
1226 - 1237	.6942	Kin Behavior

1b = = = = =101= 9%= = EXTREME SPATIAL AUTOCORRELATION

756 - 797	.7449	Political Decision-Making
481 - 528	.7472	Parental Behaviors: Warmth, Hostility, Control
561 - 575	.7639	Reproductive Rituals
986 - 1005	.8302	Importance of Kin for Children
433 - 436	.8360	Control by public opinion
1077 - 1086	.9913	Dates of Observation

= = = = = = = = = = = VARIABLE SPATIAL AUTOCORRELATION

(broken down above)

461 - 480	.1621	AGENTS & TECHNIQUES FOR CHILD TRAINING (variable)
81 - 98	.1818	POLITICAL ORGANIZATION (variable)
337 - 376	.2364	AGENTS & TECHNIQUES FOR CHILD TRAINING (variable)
293 - 336	.2485	TRAITS INCULCATED IN CHILDHOOD (variable)
405 - 432	.2685	AGENTS & TECHNIQUES FOR CHILD TRAINING (variable)
377 - 404	.3165	AGENTS & TECHNIQUES FOR CHILD TRAINING (variable)
798 - 813	.4262	DATA QUALITY CONTROL (variable)
433 - 460	.5127	AGENTS & TECHNIQUES FOR CHILD TRAINING (variable)
99 - 148	.0791	DIVISION OF LABOR (variable)

III. SPEZIELLE GEGENSTÄNDE:

TRADITIONELLE GESELLSCHAFTEN IM WANDEL