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NOW AND THEN

Comparisons of Ordinary Americans' Symbol Conventions with those of Past Cartographers

by Denis Wood

Abstract

Ordinary Americans recapitulate the history of cartography in their development of landform relief representations. The history of landform relief in the history of cartography is described and compared with the development of conventions for the representation of relief in three hundred North Carolinians between three and thirty years of age. It is concluded that the parallel development is a function of the operation of powerful principles of development controlling both individual and cultural history.

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Figures 8-11 are not included in this copy of the paper.

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The Dime Novel revolutionized storytelling in America by inventing endless ways of grabbing the reader's immediate and complete attention with a handful of words: "I dropped to one knee and fired twice," or "The girl was crazy as hell--or, if she wasn't, she thought I was." Suggesting that ordinary Americans repeat--recapitulate, if you must--the entire history of cartography as they go through the process of developing images of the world is not as as exciting as "I just lifted my foot and let the door have it," but it will have to do. It is the subject of what follows.

I

Although I am by no means the first to suggest that the history of cartography comprises an ethnogenetic developmental sequence rather than a random collection of events serially ordered in time, it is a fact that no historian of cartography has done so.[1] Despite the fact that a concern for development would seem to be implied in the very name of their calling, historians of cartography have invariably organized their chronologies--not to call them histories--as naive progressivist teleologies, in which past cartographers have been depicted as conspiring (without notable motivation) to spurn the pathetic cartographic heritage of their progenitors in a preordained stampede toward the (historian's) present state of cartographic enlighten-

ment.[2] There are many hallmarks distinguishing these chronologies: lack of attention to the cartography of primitive peoples;[3] serious difficulties with the Middle Ages, which violates the nice march of the progressivist narration;[4] profound ethnocentrism manifested in a decided emphasis on the West and its near past;[5] and a peculiar fascination with biography. But perhaps most typical, and most damning, is the absolute dearth of historical or developmental principles or explanations of any kind whatsoever. Instead, for each cartographic event, for each map, for each mapper, for each phase or stage in the history of map-making, a unique ad hoc explanation has been adduced. The result, less history than serendipity, is bound up in the fact that cartography--ever viewed, and viewing itself as a craft--has steadfastly refused to reflect upon itself, refused to deal in philosophy and theory,[6] refused even to entertain the fundamental questions of why man maps and what he is about when he does.

To each of these arenas a genetic view of the history of cartography brings the promise of, if nothing else, a very good show. This follows not merely because a genetic perspective proffers a structuring principle other than that of the ever passing years, but because if it turns out that history of cartography does reveal a developmental pattern of any generality, then anything known of similar patterns in other developmental modes--phylogenetic, ontogenetic, even pathogenetic--can be applied to the history of cartography and vice versa. Robert Beck and I had precisely this possibility in mind when we wrote:

> ... The map is a cultural concretization of man's geographic, environmental thought process, and the history of cartography preserves the developmental stages of that process. In this sense the map is a resolution of a chain of events that began long ago with the impulse to explore, the exploration itself,

the return, and the remembrance and reproduction of the experience...[7] Afterall, this is no more a description of a chain of events that began long ago in the history of our species than it is a description of that chain of events that began long ago in the childhoods of each of us when we began to live out the consequences of our individual impulses to explore the crib, the room, the home, the neighborhood...

But it is one thing to suggest a general parallelism between the map-making activities of the species as a whole and that of its individual members, and another thing altogether to demonstrate that this is in fact so. Until now two circumstances have mitigated against this demonstration. The first is that until very recently practically nothing was systematically known about the ways in which individuals "map" their world. With the maturation of geosophy, psychogeography and environmental psychology this is no longer so. Since the publication of J.K. Wright's Geographical Lore in the Time of the Crusades[8] research in these areas has gradually accelerated to the point that each year now sees the publication of a substantial monograph and numbers of papers on the topic.[9] The product of this sustained effort is an elementary knowledge of environmental cognition capable of acting as a foundation for the comparison of the ontogenetic development of mapping abilities with the ethnogenesis of cartography.

The other circumstance has been a peculiar resistance to any admission of the actual complexity of the cultural artifact that the map is. For most adults--including cartographers--the map as such seems to be an intuitively simple, even obvious thing.[10] That it is in fact a complex

convergence of ecologic situations, world-views, geometries, metaphysic, symbolic and other systems is, in any and every instance, either overlooked, or only selectively observed. For example, histories of cartography typically discuss European cartography of the Middle Ages in terms of world view and Christian theology; but this aspect of map-making is rarely raised in disquisitions on the wonders of the modern topographic sheet, although as a dimension of analysis it is clearly as relevant in the one case as the other.[11] The failure to use a common frame of analysis, the failure to employ dimensions along which comparisons are made that are invariant with respect to the subject, means that no comparison has been made at all. It is as if one compared Hank Aaron as a hitter with Babe Ruth as a pitcher. On this basis all that can be said, comparatively, is that each was wonderful in his own way. This is a sweet sentiment, but nothing more.

Once the roiled complexity of the map is acknowledged it becomes possible to deal with its subsystems incrementally. This in turn leads to the examination of its history as a function of changes in world view, or as a function of changes in the ecology of the map, as a function of changes in metaphysics, or as a function of genetic principles with respect to any of these subsystems, or as a complex function of some or all of these and others. But in any case the fundamental rule is simple: if one map is treated as a manifestation of world view, then all the maps covered must be so treated; but if one map is treated as a manifestation of a concept of space, then all must be looked at in this light. That this or that dimension of analysis sometimes seems variantly

appropriate is, in the first place, a delusion and, in the second, irrelevant. Comparisons, the very stuff of history (not to mention science), are meaningless in the absence of stable standards.

In what follows the standards will be the representation of landform relief (essentially hills and mountains). The comparisons will be among maps in the record of the history of cartography, and among several thousand experimental sketch maps and drawings collected from cartographically naive individuals between the ages of three and seventy over the past nine years. Other comparisons will be made between these two sets of images.

II

It is widely acknowledged by cartographic commentators that the representation of landform relief is one of the most difficult aspects of map-making. Thrower says: "Delineation of the continuous three-dimensional form of the land has always been one of the most challenging problems in cartography."[12] Lynam says: "The representation of mountains has always been the map-maker's hardest problem, for mountains have length and breadth as well as height, and they hide something round every corner which must nevertheless be shown on the map."[13] Robinson and Sale say: "Because of the relative importance to man of the minor landforms, the representation of landform together with other data has always been a great problem to the cartographer," and they treat landform representation apart other problems in cartographic representation, noting that the land surface "is so different from all the others as to make it almost imperative that it be treated separately".[14] Green-

hood speaks for the profession as a whole when he says:

> The way a map depicts relief is often a hallmark of merit "that distinguishes the handiwork of someone who knows," says Joseph T. Maddox, a geographer and also what might be called a connoisseur of maps. "Mountains are not heaped up haystacks of earth; they have length, breadth, and structure." ...The cartographer has had to prove himself pretty clever whenever the facts he had to show upon a flat surface were themselves about flat matters, merely two-dimensional. But in showing three-dimensional facts on a flat surface he displays his true ingenuity.[15]

Insofar as it is developed, the historic record would seem to support these observations, though belying the glib assurance of most accounts of this record is the fact that little of it is actually known. Extant maps from periods prior to the European Middle Ages are rare from any part of the globe, and few enough have come down to us from all but the end of the Middles Ages itself. Furthermore, the attempt to extrapolate about early mapping activity from the mapping behavior of contemporary primitives is freighted with a potentially disastrous cargo. Nonetheless, it is here that the record begins.

Still the best account of primitive cartography is Bagrow's brief summary forray, though the evident importance of such study is attested to by the recent work of Smith (if the Mixtec can be termed "primitive"), Spink and Moodie, Pentland, Wise and others.[16]

Eskimoes have been frequently singled out for their ability at relief representation, though it is becoming clear that they were not, as Bagrow claimed, "perhaps alone in attempting the delineation of relief features."[17] In any event, these relief representations were

usually relief models and not maps at all, which is not the same thing by any matter of means. Furthermore the renowned ability of the Eskimoes to use hachures would seem to be very much a matter of interpretation. Spink and Moodie write as follows:

> Thus, in both the maps of the Caribou and coastal Eskimo, simple line-work is used to portray the significant natural features. Generally, an unbroken line is used to represent coastline or river bank, and this is backed in appropriate places by hachuring to denote the presence of cliff or mountain sides. The representation of relief is absent from many of the maps but its occasional presence is significant...[18]

On the other hand, much of this occasional hachuring is purely a matter of interpretation on the part of earlier observers or Spin and Moodie. They frequently note that its use is inconsistent (and hence may represent some other feature of the landscape) and suggest that it might not be hachuring at all:

> In some of the maps attempts are made to more accurately depict the intricacies of relief by varying both the length of the hachure strokes and their direction. The pictorial effect is encountered in charts like Figure 17b. In this area the use of extensive hachuring is quite surprising since relief on the west coast of the bay and at its head is not particularly prominent, so the lines may have been introduced merely to emphasize the trending of land, coast and rivers.[19]

Finally they note that the hachuring appearing on some of the published Eskimo maps might have been introduced by Europeans in more than one sense:

> Native hachuring appears on few of the early charts and its later adoption may be in part a result of European influence, either by instruction or by acquaintance with the explorers' own charts. The maps collected by Captain W.E. Perry in 1822 ...lack hachuring along part of their coasts and the hachure work which is present seems, by the regular length and

> frequency of the strokes, to have been produced by mechanical means, probably at the engravers.[20]

Thus it is moot that the Eskimo exhibited any special facility with respect to the two-dimensional representation of relief features, although it is clear that they could build relief models in an amazing number of ways, and that they used hachure-like strokes to "represent" something.

But if the representation of landform relief features is actually absent in Eskimo map-making, then it is probably absent in the map-making of primitives, period. This is not to say that these peoples (for example, the Marshall Islanders of the last century or the Australian aborigines of this) do not make maps, or that they cannot indicate the location of significant landforms--merely that these landforms are not represented, or perhaps more appropriately, re-presented. With the exception of the Pre-Conquest Mesoamericans no candidates have even been put forward.[21]

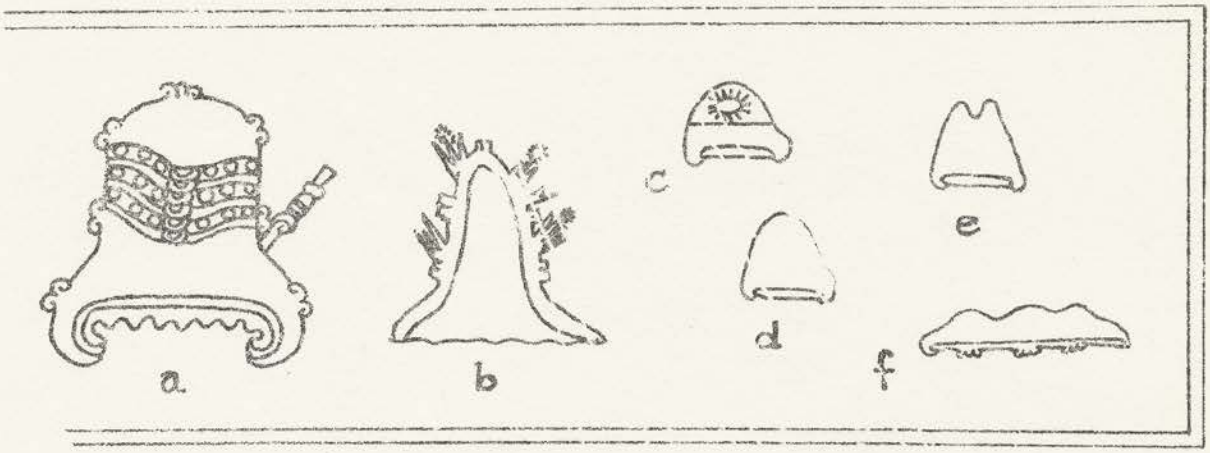
If this is the case, the "earliest" representation of landform relief may in fact be found in the "Pre-Conquest" cartography of Mesoamericans, such as the Mixtec. It is difficult to understand how Bagrow could have lumped the map-making activities of these peoples with those of the Eskimoes and the Marshall Islanders. Thrower's mention of early Mexican cartography in the same breath with that of early Egyptian map-making is much more to the point and in keeping with the position adopted here.[22] The early cartography of all the great "ancient" civilizations (China, India, the Near East, Mesoamerica)--to the extent ascertained--would seem very much to be of a type, and while the point

is too complex to argue here, the cartographic efforts of all these cultures should probably be regarded as essentially similar.

One reason for focusing on the cartography of southern Mexico is that relative to that of early Mesopotamia, Egypt or China, a fair amount is extant; and if this extant corpus actually includes excessively few examples that are genuinely Pre-Conquest, then much of it is Pre-Conquest in all but very few details. In the Mixtec case in particular it is possible to demonstrate the remarkable extent to which maps like the Lienzo of Zacatepec 1 observe the conventions employed in non-cartographic codices predating the Conquest by as many as two hundred years.[23] Among these conventions is a partial system of logographic writing in which certain forms "are not merely pictures, but logograms--signs which represent one or more words in the Mixtec language."[24] One of these logograms means "hill". Smith describes it as follows:

> The sign for the Mixtec word yucu or "hill" is essentially a conventionalized "picture" of a hill. It is usually a green or brown bell-shaped form on a base that consists of a narrow red or blue band below which there is often a yellow scalloped border. At times the lower corners of the hill sign curl inward, forming volutes on either side. Often the outline of the hill shape is broken by small curvilinear or rectilinear projections which indicate the roughness or "bumpiness" of the hill. The hill sign has many variant shapes. For example, one side of the hill may be extended in a manner that suggests a slope, and at times this extended slope functions as a platform for human figures.[25]

Logograms like this for yucu were used in two readily differentiated fashions. On the one hand they were used much as we use words, to name a place, and it is in this fashion that they appear in the historical narratives of the codices. On the other hand they were used much as we use a combination of words and symbols on a map, to identify and locate



Mixtec and Nahuatl hill-signs. (a) Codex Nuttal (b) Lienzo of Zacatepec 1 (c--f) Codex Tepetlaoxtoc

a place, and it is largely in this fashion that they appear on the Mixtec maps, "largely" because their use on these maps was really more complex. Smith describes their non-historical-genealogical uses on Lienzo of Zacatepec 1:

> ...the large rectangle formed by the boundaries contains three types of place signs: (1) "non-cartographic signs"--that is, signs of towns which are actually located outside of Zacatepec's boundaries but which are placed within the rectangle of boundaries in the Lienzo, (2) the signs of Zacatepec's estancias or subjects, and (3) signs of uninhabited geographical features such as hills and rivers.[26]

The most interesting feature of this representational system is the flux it indicates in intentions: linguistic and pictorial, narrative and cartographic. At this early stage in the development of landform relief symbols, signs originally developed as names to be used in narratives are being adapted as "pictures" to be used on maps. And yet in these early Mixtec maps the transition was not complete and in Smith's words, "The

place sign is not a generalized portrait of a hill based on perception; it is a pictorial sign that reflects language rather than landscape."[27] However, a hill-form did, in this manner, find its way onto a map and this likely represents the earliest sort of hill symbol.

It is unknown how the Mixtec, and the Nahuatl, would have continued this development toward cartography for it was at precisely this stage in the process that the Conquest occurred. It is, however, possible to see how this hill sign was generalized under European influence, as in Lienzo Zacatepec 2 which was produced only two generations after the earlier version; or in that part of the Codex Tepetlaoztoc reproduced in Bagrow.[28] In the latter it is very obvious that the hill place-sign was simply generalized into a generic hill-sign, and it appears in four variants: as a place-sign (with the additional logographic signs needed to "spell-out" the proper name), in identical form but as a generic hill, modified to indicate peculiarities of shapes in hills, and multiplied into a range of hills, or perhaps mountains.

The similarity of this latter multiplied-form of the hill-sign to that on the clay map of northern Mesopotamia (the Nuzi, c. 3800 B.C.[29]) is sufficiently striking to suggest that a similar process of cartographic sign-making might have transpired in Mesopotamia via the early Sumerian ideograms, and in fact, if you'll excuse the poorly founded character of this generalization, in all map-making civilizations in which landform relief is represented. That is, early cartographic sign-making probably developed conjunctively with early linguistic sign-making, writing and mapping both growing together at first, sometimes difficult to completely

separate, but subsequently following increasing distinctive routes. This fusion is clear in the Mixtec and Nahuatl cases, and the proximity of the approximate dates assigned the Nuzi map (c. 3800 B.C.) and the development of Sumerian ideograms (c. 3500 B.C.) is similarly suggestive. Weaker cases along the same lines can be made for Egypt and China.

Whatever the very early origins of landform relief signs, in the West their character was little changed in the four or so thousand years following their appearence on the Nuzi map. Those that show up on the Tabula Peutingeriana (c. A.D. 500) are rather more than kissing cousins, and no really notable changes occur until the later Middle Ages, from which period the history of landform representation is quite well known. Speaking of the cartography of the 12th and 13th centuries, Wright observes:

> Symbols representing the various features of the earth's surface were more or less conventionalized, though we can hardly say that any definitely developed "conventional signs" were in use... On medieval maps such elements as mountains, forests and cities were shown as they appear from the side... Mountain ranges were generally represented by jagged, sawtooth lines running parallel to straight lines; particularly high or famous peaks by a single great pyramid. Such pyramids are prominent features in the Beatus series...[30]

From this period forward the history has been frequently summarized. In Lynam's account, covering the period from about 1250 to 1800, the essential changes involve a gradual shift from an elevation or profile view ("rather like cock's combs"), through an oblique or bird's-eye view ("little rows of shady sugar-loaves"), to the use of the plan view (leading in the 18th century to the hairy caterpillars "found crawling across maps of Asia and America until the end of the 19th century"). This shift in per-

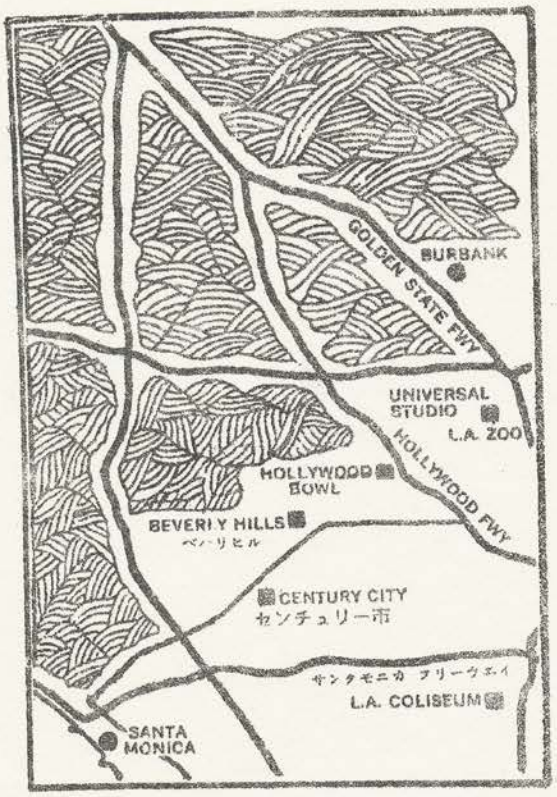


Figure 2. Portion of a map of Los Angeles intended for the use of Japanese tourists

spective was paralleled by the development of conventionalized shading, from the arbitrary medieval practices of shading profile views, through the "obliquely" and usually eastern shading of later bird's-eye views, to veritable vertical shading of plan views.[31] This led, in Skelton's view, to the development of hachuring:

> Early in the eighteenth century, cartographers began to draw their hill-hatching as if vertically shaded or illuminated from a source above the object. From this method, which facilitated the representation of relief features in plan, developed hachuring by parallel lines drawn in the direction of the slope, the steepness being indicated by the thickness of the hachuring and the interval between them. This con-

> vention was used with plastic effect in 1757 in the physical maps of Philippe Buache.[32]

But Buache had already used contours on maps twenty years earlier (1737), and by the time hachuring became adequately refined (in the 1799 work of Lehmann), it was already being supplanted by the use of this still more abstract convention, although it took most of the 19th century to establish the contour's supremacy.[33] On small-scale maps, use of contours resulted in layer-tinted relief representation, both with and without shading. A number of other techniques have since been propounded, but as Robinson and Sale point out, "Most of them are relatively complex and intellectually involved. Their use is limited to the professional geographer and geomorphologist, whose knowledge of landforms is sufficient to interpret them."[34] Of course this was once said of layer tinting, contours and hachuring--probably of all innovations in relief representation--but Robinson and Sale would not seem to imply that the history of the development of relief representation has come to an end. In fact, as they look into the future, they suggest the opposite, that it has a long way to go: "For many years to come the representation of land form on maps will be an interesting and challenging problem, since it is unlikely that convention, tradition or the paralysis of standardization will take any great hold on this aspect of cartographic symbolization."[35] This seems especially likely in view of the fact that the full panoply of historically developed types is currently in wide use. If the plan view and the contour have taken over the largescale topographic survey, the bird's-eye view and hachuring are very much in

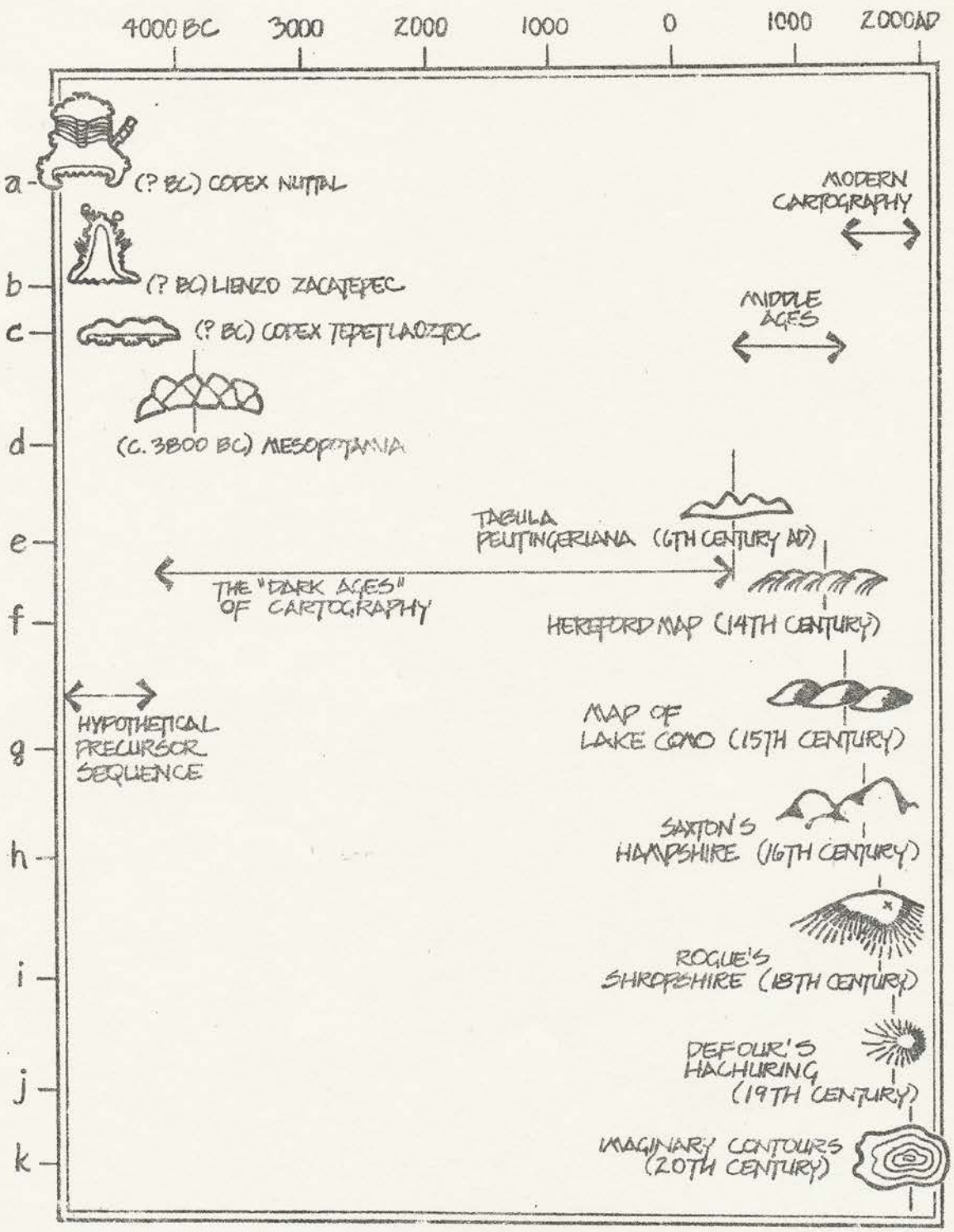


Figure 3. The ethnogenesis of hill-signs. The hypothesized precursor sequence is that illustrated in Figure 1

evidence in physiographic diagrams, landform and perspective maps. Despite Raisz' caution that his tachographic symbols "not be placed so regularly as to look like fish scales", they still look like they were nurtured on a small-scale map of the 16th century.[36] An even more primitive hill-sign can be seen on a recently produced map of Los Angeles slanted toward Japanese tourists. Though clearly derived from the tradition of the Japanese woodcut, this sign rustles back through late medieval woodcuts (with their "mountains portrayed as enormous overlapping slabs of rock" in Lynam's words) to the very earliest attempts at portraying relief.[37] These and other historic forms thrive among us.

This, briefly, is the known history of relief representation. While not well developed for China, India and other parts of the non-Western world, from what is known, it would seem to be not radically different. The entire sequence, as described here, is graphically summarized in the accompanying figure.

III

If professional cartographers regard relief representation as a challenge, the average American regards it as something more--or less. In a sample of 2050 experimental sketch maps pulled from my collection to represent a diversity of mappers, terrains and scales, only 157 (less than 8 percent) included any represented relief, although a number of others had the words "hills" or "mountains" written in appropriate locations. When shown, the relief by and large consisted of highly schematic,

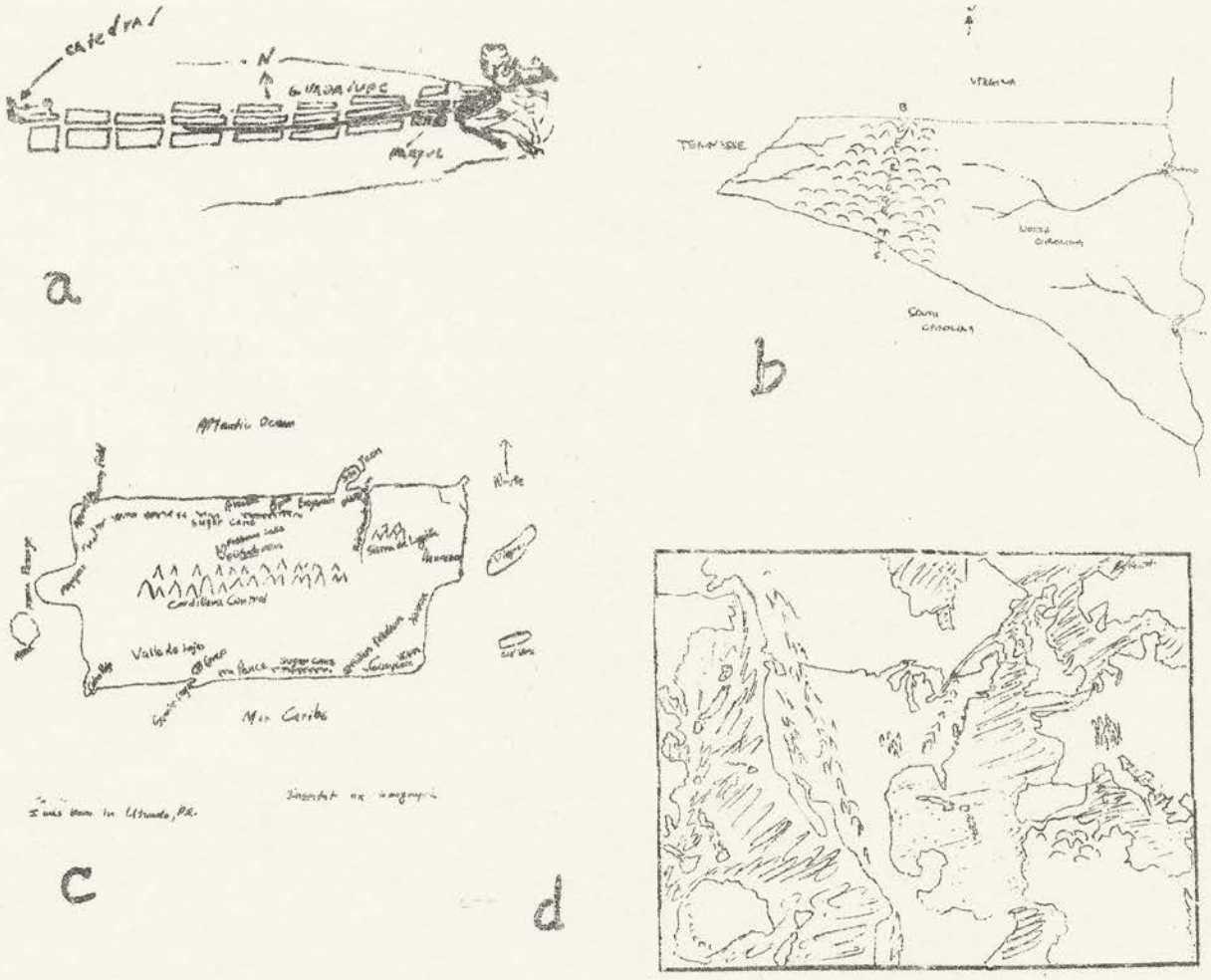


Figure 4. Some hill-signs from sketch maps. (a) an oblique "picture" on a large-scale sketch of a barrio in San Cristobal las Casas (b) North Carolina as drawn by a Kansas college student (c) Puerto Rico from the pen of a native secondary-school teacher (d) the world by an adult resident of Connecticut

"oblique" views of mountain ranges at the state (North Carolina, Puerto Rico) or smaller scale (the United States, Latin America, the World). Relief shown at larger scales invariably took the form of oblique pictures.[38] A review of the few experimental sketch maps that have been published by others would strongly support these findings--few examples of relief at all and those highly schematic at the state or smaller scale--with the exception of a set of "drawings" of the San Fernando Valley collected from first, third and fourth graders by Klett and Alpaugh. Of the ten drawings they reproduce, five include obvious representations of relief: Three of these are schematic obliques, one a shaded oblique and one a schematic profile.[39] In general then, without respect to terrain, age or culture, few cartographically naive mappers volunteer representations of landform relief. Those that do, do so at relatively small scales and employ highly schematic bird's-eye views of mountain ranges.

That this might suggest a lack of awareness of or interest in landform relief can, I think, be dismissed without lengthy discussion. In an ongoing study I am looking at the roles played by landforms in the world of children, who are accutely aware of the existence of slope and actively exploit it in bicycling, skate-boarding, skating, sliding, sledding, rolling, jumping and "flying". In selecting routes for the traversal of urban environments, cycling children seem to try to maximize the possibilities of going down hills while minimizing the necessity of climbing them. The same seems to be true of ambulatory adults. In image work employing both verbal and graphic interrogatories,

landforms are much more frequently written about than mapped. For instance, in my work in San Cristobal las Casas, Mexico, a dominant hill in town was the twelfth most frequently mentioned landscape feature, but only the twenty-first most frequently mapped (n=176), and the same sort of ratio was observed in descriptions of individual neighborhoods in the same town (n=92).[40] Neighborhood maps of a hundred high school students in Worcester, Massachusetts--a town known for its "seven hills"--frequently included the word "hill", often in neighborhood names (as in Grafton Hill), but lacked representations of relief. Numerous other examples could be given, but the point should be clear: the failure to volunteer relief representations on experimentally collected sketch maps is not a function of a lack of interest or awareness on the mappers' part.

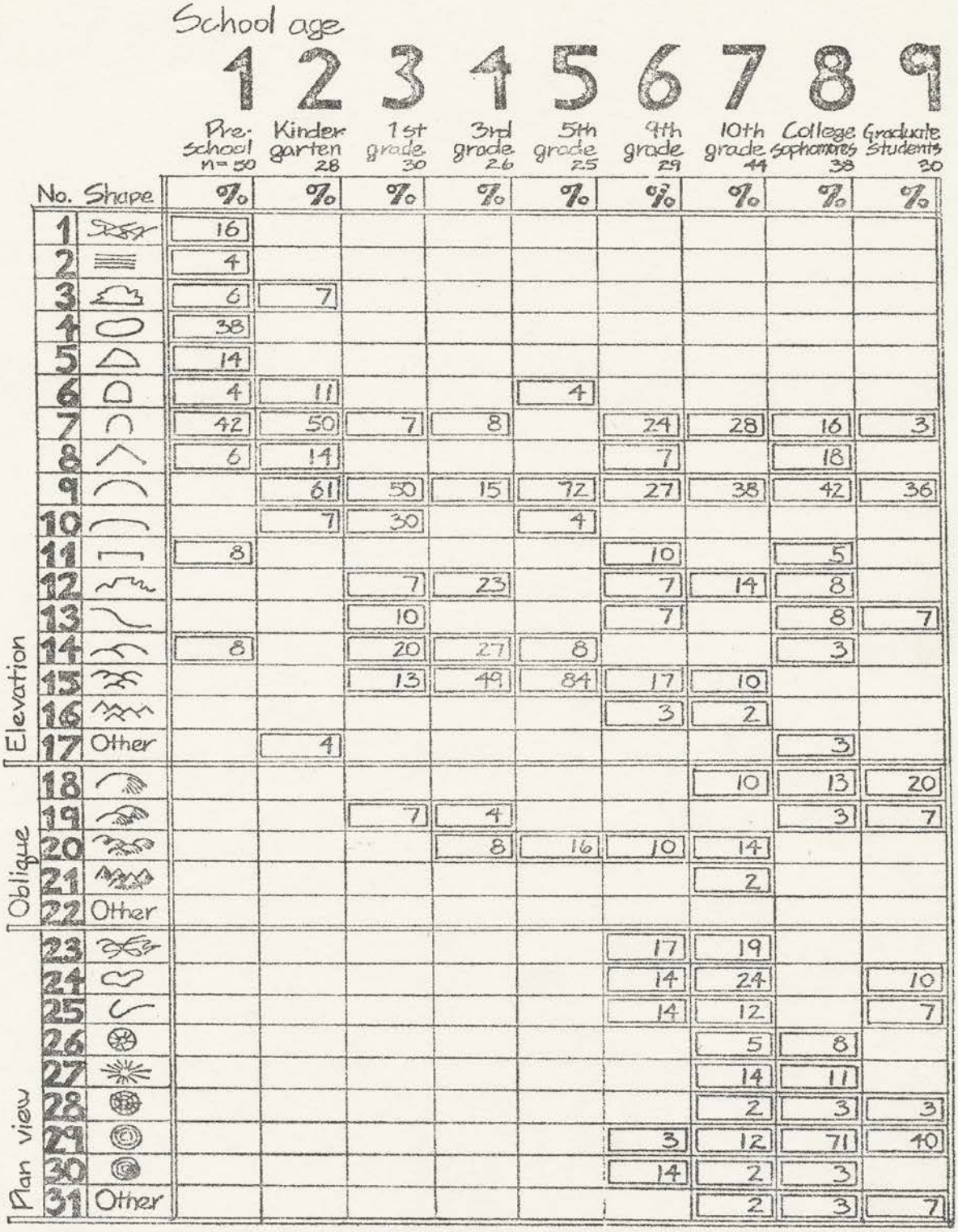
This failure can instead be directly attributed to the sorts of difficulties faced by professional cartographers. Landform relief representation is not simple and--given the level of accuracy implicated in experimental sketch mapping--this is especially true at larger scales. Robinson and Sale thoroughly cover the nature of this problem when they say:

> If he shows the surface in sufficient detail to satisfy their local significance, then the problem arises of how to present the other map data. On the other hand, if the cartographer shows with relative thoroughness the nonlandform data, which may be more important to the specific objectives of the map, he may be reduced merely to suggesting the land surface...[41]

In their view, advances in color printing have enabled "the cartographer to reach a relatively effective combination of techniques, without undue

sacrifice of either desirable end."[42] This merely underscores the magnitude of the task facing the naive sketch mapper: it is a lot to ask of him that he show an urban street system and at the same time adequately portray relief. The naive mapper makes a choice of what to show and nine times out of ten he opts for culture. The same case--that the naive mapper faces the very problems of the cartographer--can be made for small-scale maps. Robinson and Sale argue that one thing that historically retarded the representation of relief over large areas was a paucity of knowledge about landforms. Needless to say, this is the situation facing a cartographically naive resident of San Juan trying to map the Cordillera Central of Puerto Rico. The most that might accurately be known is the generalized extent of the major aggregate feature (e.g., mountain range), and this is as adequately represented by its name inside a line embracing the region occupied as it is by a row of teeth or fish-scales. When anything more elaborate is attempted, the same problems arise in the small-scale as in the large-scale case.

Thus, the failure to represent landform relief on 92 percent of 2050 sketch maps probably not only does not reflect a lack of interest or awareness of such relief, it also does not reflect any peculiar difficulty not historically faced by the map-making profession itself. In fact, it likely does not reflect on the cartographically naive mappers' abilities to represent landform relief at all, but simply on the fact that they have not spent their lives consumed with the attempt to solve this particular cartographic problem, namely, the representation of landform relief <u>conjunctively</u> with other landscape attributes. How,



No.	Shape	Pre-school n=50 %	Kinder garten 28 %	1st grade 30 %	3rd grade 26 %	5th grade 25 %	9th grade 29 %	10th grade 44 %	College sophomores 38 %	Graduate Students 30 %
Elevation										
1		16								
2		4								
3		6	7							
4		38								
5		14								
6		4	11			4				
7		42	50	7	8		24	28	16	3
8		6	14				7		18	
9			61	50	15	72	27	38	42	36
10			7	30		4				
11		8					10		5	
12				7	23		7	14	8	
13				10			7		8	7
14		8		20	27	8			3	
15				13	49	84	17	10		
16							3	2		
17	Other		4						3	
Oblique										
18								10	13	20
19				7	4				3	7
20					8	16	10	14		
21								2		
22	Other									
Plan view										
23							17	19		
24							14	24		10
25							14	12		7
26								5	8	
27								14	11	
28								2	3	3
29							3	12	71	40
30							14	2	3	
31	Other							2	3	7

Figure 5. The ontogenesis of hill-signs. School age is shown on the horizontal axis; hill-sign type on the vertical.

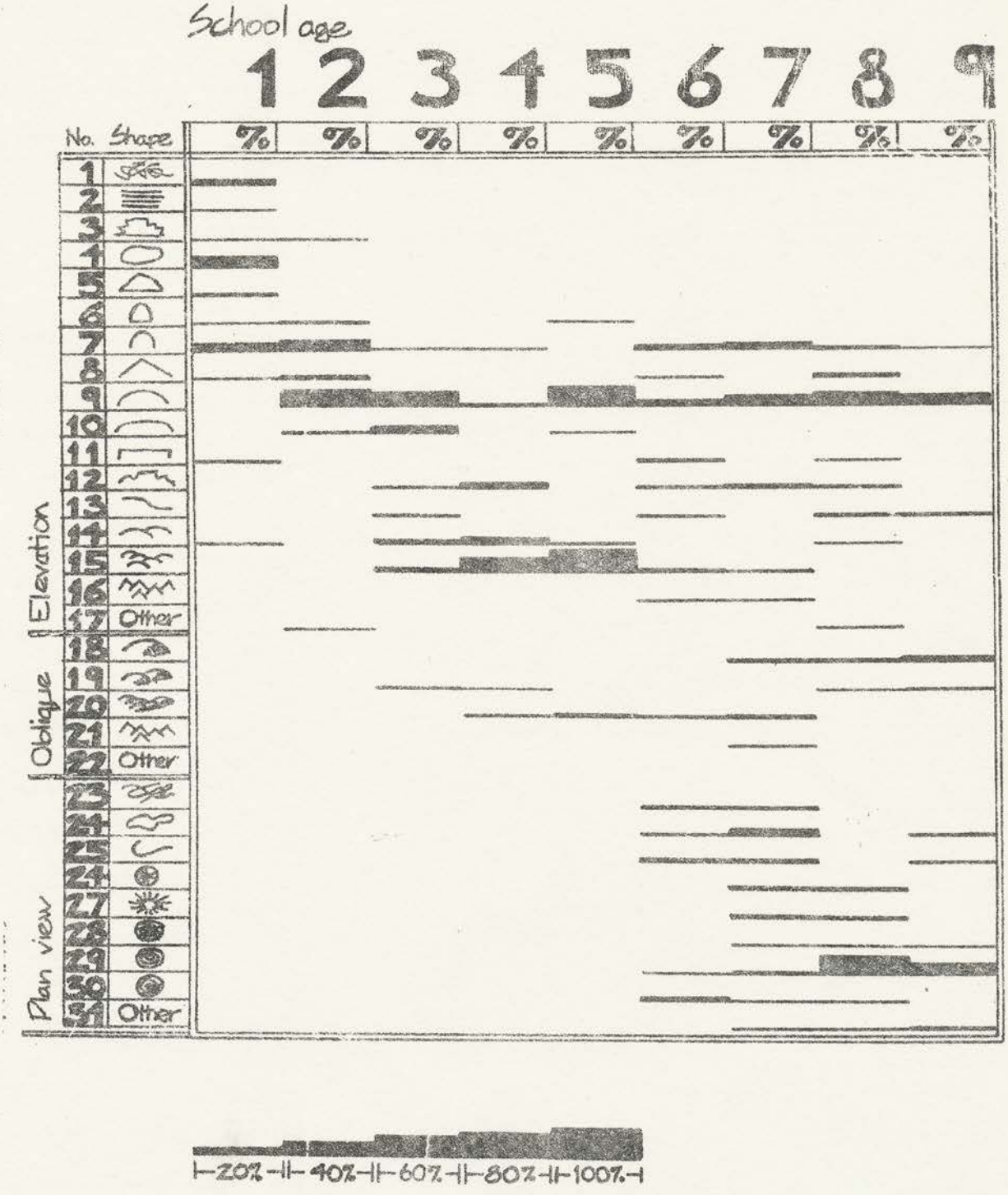


Figure 6. The ontogenesis of hill-signs. Source: Figure 5.

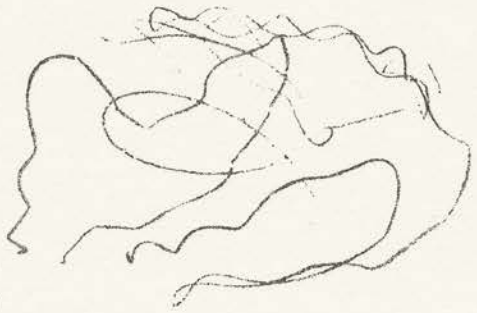
then, would such mappers go about representing relief if this were the only task set?

To address this question a set of five-hundred drawings of hills was collected from three-hundred individuals between three and thirty years old. North Carolina residents to an individual, they lived in each of the state's three distinctive physiographic regions, the coast, the Piedmont, and the mountains. The youngest children were simply asked to draw a picture of a hill, though the stories they told about each drawing were recorded along with other pertinent data. The older children and the adults were subjected to more elaborate tasks and inquiries. Important here is the fact that the four oldest groups (see Figure 5) were asked either to draw profiles, obliques and plans in that order; or to draw a hill, and then to draw it from the other perspectives. The difference is that some of the individuals in the four oldest groups were told from what perspective to prepare their first drawing, whereas others were free to choose this initial perspective themselves. All of the drawings were examined from the viewpoint of perspective (elevation or profile, oblique and plan), hill form, and number of hills shown. The results of this examination, the number of individuals in each age group, and the percentage of individuals in each age group drawing a given hill type are displayed in Figure 5. Due to the fact that about two-thirds of the respondents drew an average of two hills each, none of the columns sums to 100 percent. The same information is more graphically portrayed in Figure 6.[43]

As can instantly be seen, there is a pronounced relation between age and both point of view and the range of hill types used. That is, with

increased age there is an increased likelihood of representation in plan and an increased repertoire. This repertoire is illustrated in Figures 7-15, which have been organized to indicate something of the diversity of types within age groups, as well as to highlight the salience of those types running across age groups like the brilliant colored threads in a hempen rope. Of special significance is the montiform complex embracing types #7, #9 and #10 (see Figure 5).

With few exceptions the drawings speak for themselves. A small number of respondents across age groups emphasized slope as the essence of hillness by drawing things like roller-coasters and roofs instead of geomorphic hills. A smaller number of kids, confined to the youngest groups, drew animate hills such as those seen in Figures 7 and 8. (Those circles with rays on one of the type #4 hills in Figure 7 are "the eyes of the hill".) When these very young children <u>were</u> asked to draw hills as seen from above, drawings identical to those otherwise made were produced. This is not to say that these kids could not have been taught to do so, but simply that they hadn't yet discovered (learned) how.[44] When those at the four upper levels were given the opportunity to draw their first hill without prior suggestion as to point of view, they did so in relative consonance with the ratios shown for the data as a whole; that is, there was a strong relation between their abilities and their preferences. It should be noted that the college and graduate students attended North Carolina State University, an agricultural and technical institution. Their inclination to draw plan views might not reflect that of the population at large. With this exception, however, the data are a good



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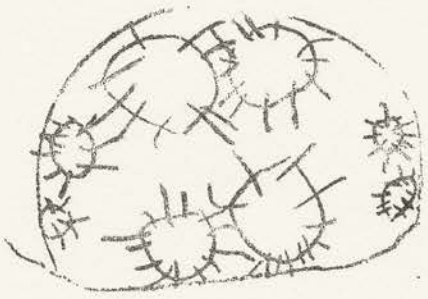

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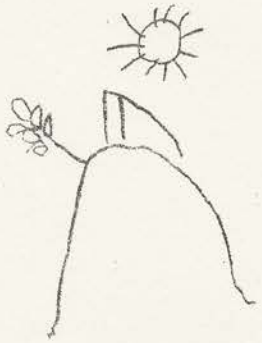
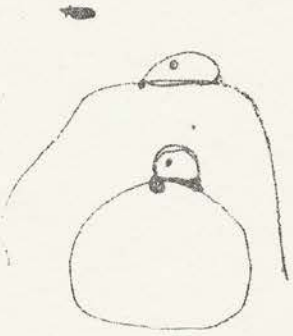


7.1



14.1

Figure 7. Examples of hills drawn by preschoolers (20 four year olds, 20 five year olds, 10 six year olds). Codes refer to school age group (1-9: see Figure 5) and then to sign type (1-31: see Figure 5).

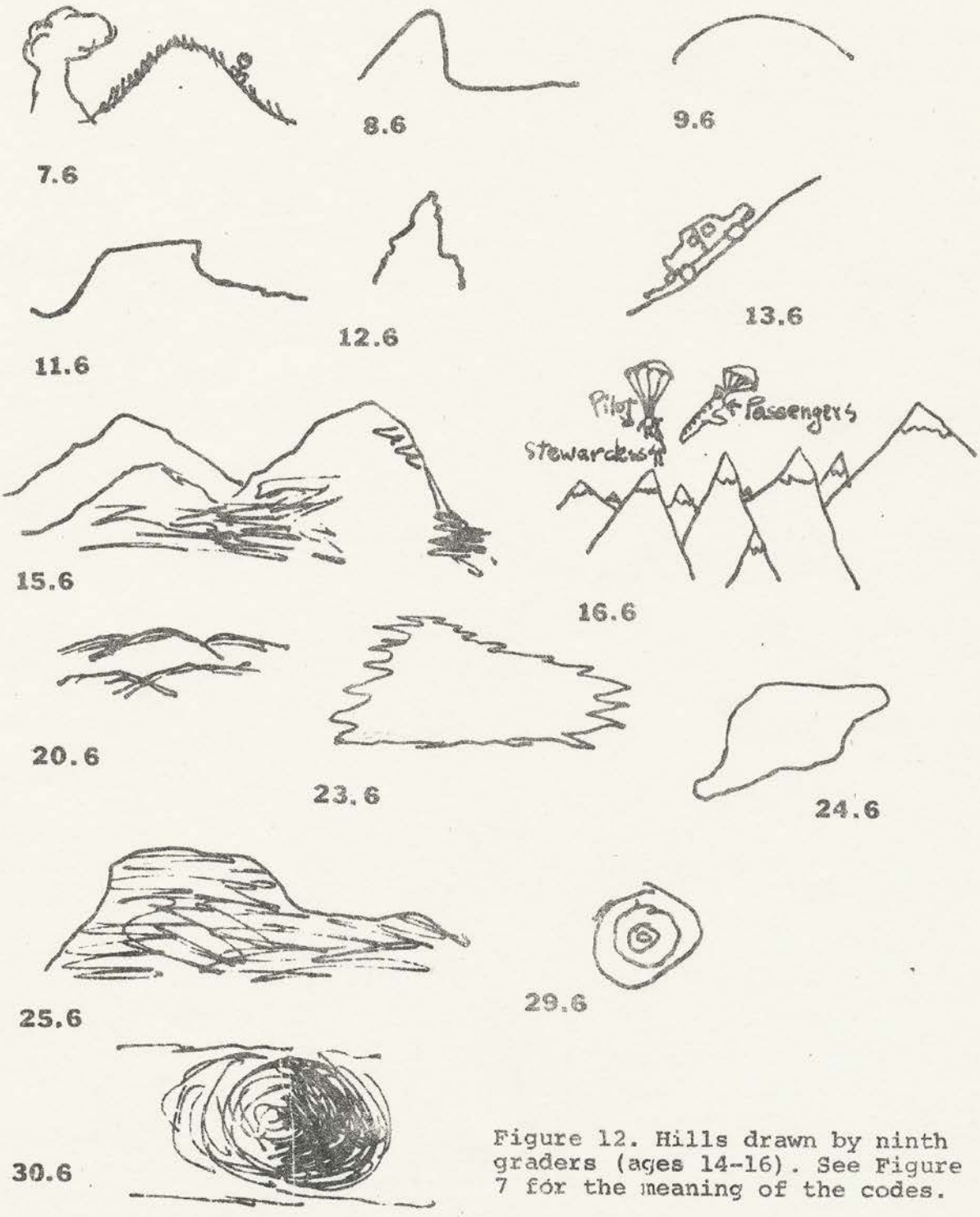


Figure 12. Hills drawn by ninth graders (ages 14-16). See Figure 7 for the meaning of the codes.

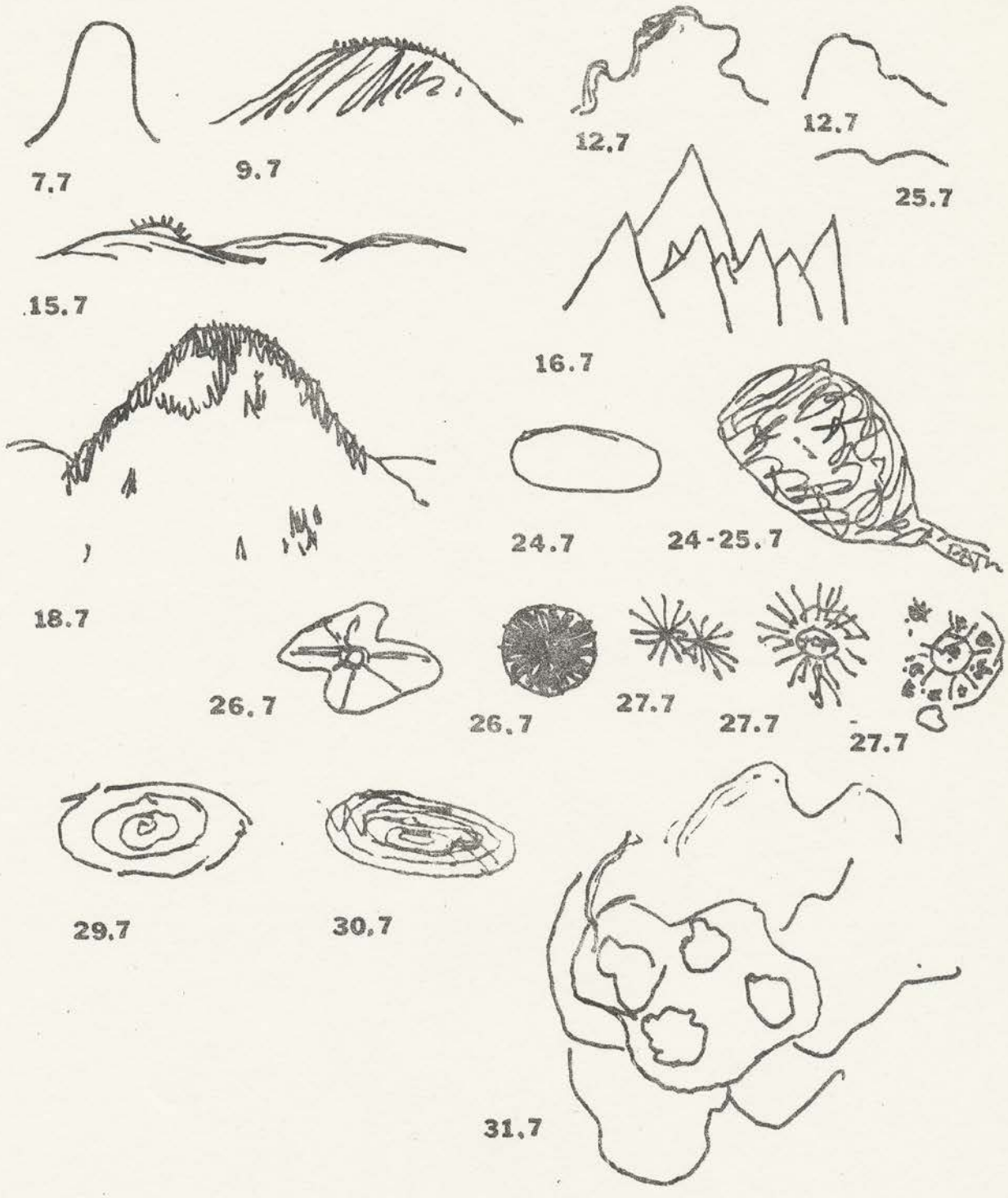


Figure 13. Hills drawn by tenth graders (ages 15-17). See Figure 7 for the meaning of the codes.

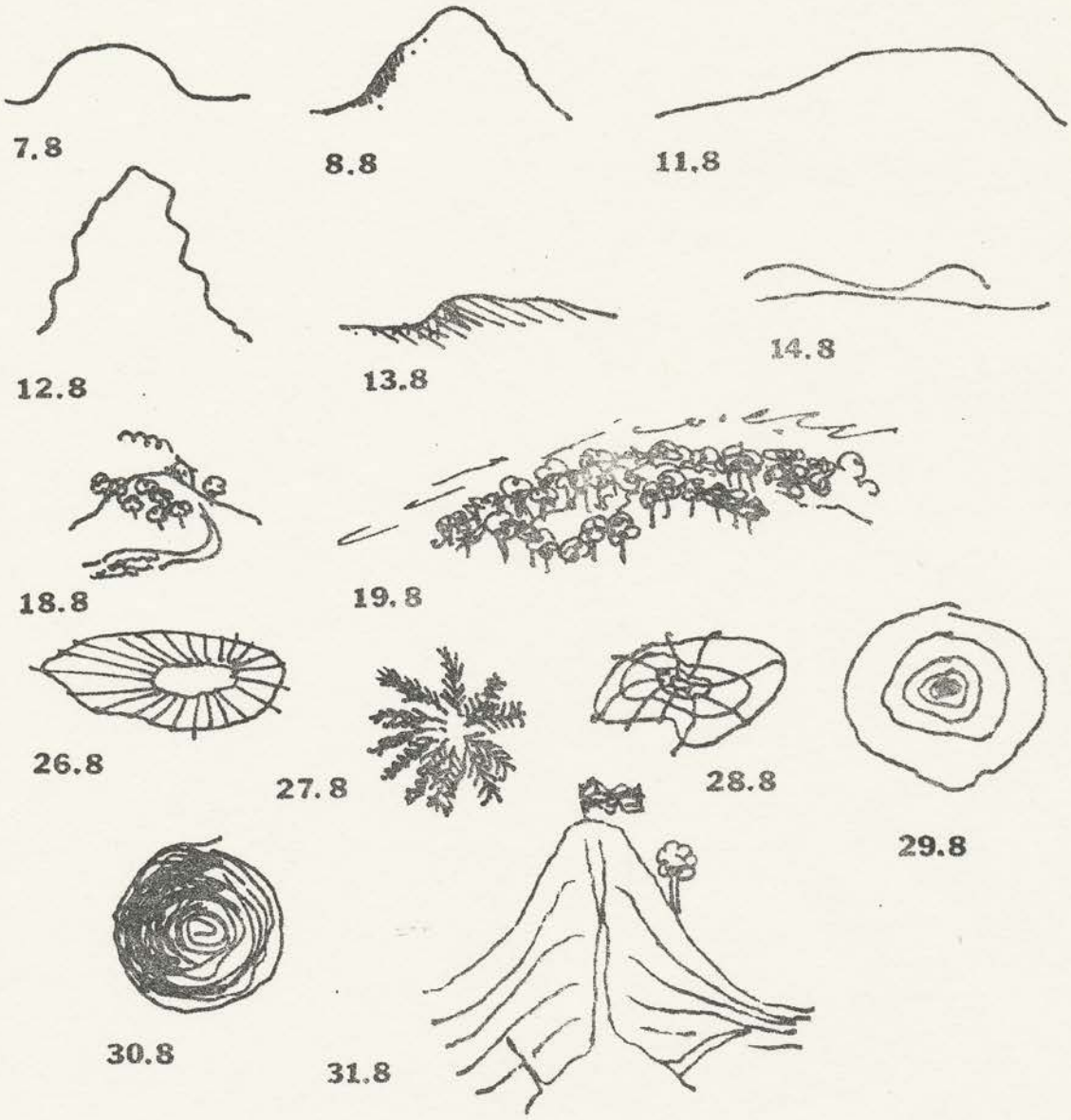


Figure 14. Hills drawn by college sophomores (ages 19-21). See Figure 7 for the meaning of the codes.

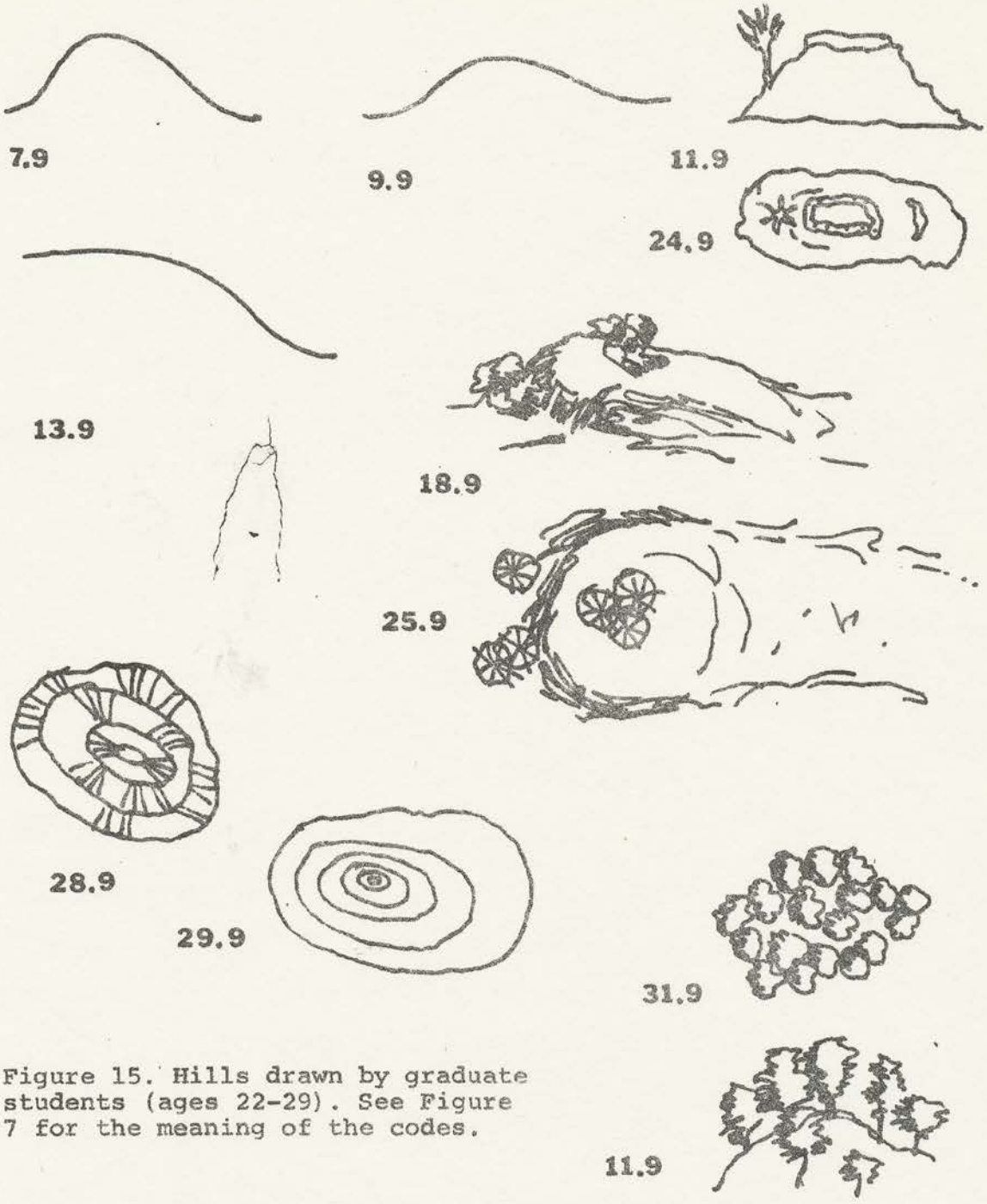


Figure 15. Hills drawn by graduate students (ages 22-29). See Figure 7 for the meaning of the codes.

indication of the range of hill-form types available to and used by most Americans.

IV

Comparison of Figures 3 and 5 reveals a striking parallel between the development--latitudinally construed--of hill-form types in contemporary Americans with the development--construed partially latitudinally and partially longitudinally--of hill-form types in the history of map-making at large. The parallel is more than an artifact of similarly constructed figures. It is more than apparent. It is real. In each instance the hill-form is initially a concrete picture of a hill, medially an abstraction based on the shadow-throwing property of hills, and finally an abstraction founded on the abstraction of elevation. In each case the hill-form starts out as a generic hill, as any hill and as all hills, becomes differentiated into types of hills, isolated, rolling, foothills, mountains, and ends up capable of representing uniquely any instance of whatever character or magnitude of relief. In the beginning in both cases the hill is represented as seen from the egocentric perspective of a typical human, frontally, in elevation, later is represented as seen from the "unhuman" perspective of a bird's-eye, and finally is shown as seen impossibly, directly overhead, from a plane. In both cases the pool of potentially useful hill-forms, initially extremely small and thoroughly unorganized, gradually broadens until ultimately it embraces nearly the totality of developed forms in an organization of hierarchic integration. In this, each of developed hill-forms is retained, having been--as it were--brought forward, but its use is subject to superordinate consider-

ation of the mapper's intentions to communicate, record or analyze.

It is not, in order words, merely that the same sort of hill-forms show up in both situations, but rather that nearly identical forms materialize in the identical order moving from the same beginning point to the same conclusion. The sequences are, in fact, parallel.

But so what? The parallel could be merest coincidence. Or, equally trivially, one of the sequences could be the simple and direct cause of the other. Or the parallel could reflect some kind of crazy incremental interaction between the two. Or it could mean that both sequences were similar effects of an identical cause. Actually, none of these simple explanations quite makes it, for the real explanation is a good deal more complex, being compounded of parts--barring coincidence--of all of them. Thus, to a certain limited extent the parallelism results from the fact that individuals becomming cartographically mature or sophisticated increasingly learn and deploy the hill-forms recently given in their culture. This is to say that the parallels along the "recent" end of the sequences result because maturer individuals "copy" the historically elaborated forms.

These historical forms, on the other hand, and a much greater portion of the parallel, result from an incremental interaction between individual development and cultural development over long periods of time. Cultures develop, not independently, but as functions of the potentials of the individuals generating it, in their ecologic context, even as the individuals themselves develop as a function of the extent to which the culture to which they are party is developed. In this context maturation becomes

a measure of the extent to which an individual has acquired mastery of his culture, mastery of the accumulated activity-potentials elaborated and stored in his culture group's past. Beyond maturation, individuals--faced with novel functions not yet encountered in the culture group's past--respond with the creation of novel forms, which are in turn culturally stored and transmitted to succesive generations of individuals, who must then master also these forms in order to reach maturity. And so it goes, culture acting as the rungs on an endless ladder enabling the climbing individual to construct yet higher rungs which then become platforms for future climbers. It is this ethnogenetic-ontogenetic interaction that describes the bulk of the parallelism, subsuming, as merely the most recent case, the "copying of history" described first.

This interactive explanation itself, however, is subsumed in the most general and powerful explanation, which describes not merely how the child comes to draw hills as he does <u>prior to significant exposure to the culturally transmitted</u> forms, but why he individually, and the culture as a totality, follow the peculiar sequence observed in both cases. For while the previous explanations might suggest why college students draw hills with contours in preference to any other form, or why C.J.R. Tolkien used bird's-eye views in his maps of Middle Earth (but contours in his map of Gondor and Mordor), they cannot explain why four, five and six year olds--without notable access to Mixtec Codices or Roman route maps--employ the hill-forms that materialize earliest in the history of map-making; nor can they suggest why older kids and later Medieval cartographers <u>necessarily</u> move from elevations to obliques rather than

plan views.

Here recourse must be made to the family of structural principles of development described by Cassier, Werner, Kaplan, Piaget and their numerous progeny.[45] Their argument is essentially that development is an adaptive process ensuring organismic stability through increasing flexibility as a function of movement from environmental orientations that are concrete, fused (or global) and egocentric to environmental orientations that are abstract, differentiated and perspectivistic, and in which the parts are hierarchically integrated subordinations of the whole.[46] The subsidiary principle of cultural or functional instrumentalism is invoked to explain why a given individual in a culture or even a given culture (in which case it should probably be termed ecologic perspectivism) is differentially developed, that is, why an individual could be linguishtically mature while cartographically undeveloped, or a superb athlete and a lousy cook. The point is that cognitive skills, representational systems or activity-potentials develop as a function of the uses to which they are put and as a function of the demands that are made on them,[47] as well as in accord with the fundamental structural principles of development themselves.

While too complex to detail here, on the face of it these two powerful principles are capable of embracing not merely the movement from the concrete, undifferentiated, egocentric hill-sign of the pre-school child to the abstract, endlessly differentiable, perspectivized contour system of the adult; nor only the similar movement from the Mixtec hill-sign to the layer-tinting of contemporary world atlases; nor even the fact that

the two systems are parallel; but additionally that landform relief representation developed at a different rate from that of other aspects of map-making, that it varies with scale, that different cultures develop cartographically at different rates, and that individuals within cultures vary in the mastery of their cartographic heritage. In this light it can be seen that the history of cartography as a developmental process, at least with respect to hill-form signs, requires no ad hoc explanatory mechanisms whatsoever, and is, at least in its broad sweep, entirely independent of the particular political histories of its patrons or the idiosyncratic biographies of its practitioners.

On the other hand, this is very much a two-way street. A firmly grounded history of cartography has much to offer what is in reality but the nescient science of development. This is particularly true with respect to the creation of novel forms (the engine driving cultural development) and the interaction of culture and individual development. The "functional shift" and the "form-function interrelationship" invoked by Werner and Kaplan in their theoretical description of the evolution of novel forms for novel functions are not well understood in the mature adult; and while they seem to adequately describe the transferral of certain cognitive skills from one realm to another in the developing child, do not seem capable of dealing with the kind of creative activities involved in the switch from hachures to contours.[48] Here biographies of the creative, generative behavior of cartographers could contribute not only extremely valuable data, but developmental insights themselves. The same is true for the relation of the individual to his culture,

especially in light of Bruner's insistence "that cognitive growth in all its manifestations occurs as much from the outside in as from the inside out," and his observation that "one finds no internal push to growth without a corresponding external pull, for, given the nature of man as a species, growth is as dependent upon a link with external amplifiers of man's powers as it is upon those powers themselves."[49] Here the serious examination of cartographic innovation in relation to culture and civilization in its broadest and most particular patterning could shed a brilliant light, of which this tentative forray--ever mindful that the path to knowledge is littered with the wreckage of premature generalization--is the merest premonitory glimmer.

Raleigh, North Carolina
May, 1977

NOTES

1. The point, initially made by George McCleary and myself in our talk, "Who Cares and Why Nobody Does", at the cartographic history sessions of the 1972 meetings of the Association of American Geographers in Kansas City, was broadly conceded at the time. I am not aware of any subsequent assertion to this effect in the cartographic literature although some of the work cited below, without explicitly making the point, adopts it in fact.

2. A recent and notable exception is David Pentland's "Cartographic Concepts of the Northern Algonquians", The Canadian Cartographer, December, 1975.

3. Despite Leo Bagrow's avowed interest in the subject he devoted three and a half of his 201 text pages and three of his 116 plates to primitives (and these included the Aztecs!) in his History of Cartography (revised by R.A. Skelton, Harvard University Press, Cambridge, 1966).

4. The only apologist for the Middle Ages is R.V. Tooley in his Maps and Map-makers (second edition, Batsford, London, 1952). He observes: "The ignorance of the Middle Ages, so often inferred by later commentators, comes somewhat ungenerously from the specialist, who frequently criticizes but one facet of their activities, and in cartography this applies with particular force, due partly to the paucity of extant records... but also to a misapprehension of the motives actuating medieval thought". For the rest, their treatment of the Middle Ages is a positive scandal.

5. Bagrow, op. cit., covers the non-Western world in a handful of concluding pages; Lloyd Brown (The Story of Maps, Little, Brown, New York, 1949) doesn't even bother with that many: for Brown the story of maps is the story of the West; Tooley, op. cit., spends five of his 134 pages on the non-West; the articles on cartography in A History of Technology (edited by C. Singer, E. Holmyard, A. Hall and T. Williams, Oxford University Press, New York, 1954-1958, in five volumes) don't start appearing until Volume III: From the Renaissance to the Industrial Revolution and solely concern the West; and so forth and so on.

6. For a long time the only interesting exception to this was The Philosophy of Maps: Michigan Inter-University Community of Mathematical Geographers Discussion Paper #12, June 1968, edited by William Bunge, but of course, none of the contributors were professional cartographers. Neither was James Blaut who wrote two papers on the philosophy of cartography in 1954 ("The Language of

Maps", The Professional Geographer, January, 1954) and 1971 ("Space, Structure and Maps", Tijdschrift Voor Econ. En Soc. Geografie, January/February, 1971). And there have been others. But until the recent publication by Arthur Robinson and Barbara Petchenik of The Nature of Maps: Essays Toward Understanding Maps and Mappers (University of Chicago Press, Chicago, 1976) there had been no similar serious effort by cartographers themselves. As to theory, W.R. Tobler notes that this is of two types, geometrical and substantive. I will not argue with Tobler when he claims that the geometrical content of a map is well understand, and I will applaud him vigorously when he goes on to say: "The theory of the substantive content of geographical maps, on the other hand, is quite unsatisfactory, incomplete, and disjointed--an assertion which I think will be proved by the history of the next several decades". He makes the remark in "The Geometry of Mental Maps", in Reginald Golledge and Gerard Rushton, eds., Spatial Choice and Spatial Behavior, Ohio State University Press, Columbus, 1976, 69.

7. Robert Beck and Denis Wood, "Cognitive Transformations of Information from Urban Geographic Fields to Mental Maps", Environment and Behavior, June 1976, 203.

8. J.K. Wright, Geographical Lore in the Time of the Crusades, American Geographical Society, New York, 1925; reprinted by Dover Publications, New York, 1965.

9. To list at least the most recent important monographs: Roger Downs and David Stea, Maps in Minds, Harper and Row, New York, 1977; Gary Moore and Reginald Golledge, eds., Environmental Knowing, Dowden, Hutchinson and Ross, 1976; Thomas Saarinen, Environmental Planning: Perception and Behavior, Houghton, Miflin, Boston, 1976; Peter Gould and Rodney White, Mental Maps, Penguin Books, Baltimore, 1974; Roger Downs and David Stea, eds., Image and Environment, Aldine Books, Chicago, 1973; and this just scratches the surface of what's available.

10. Ronald Carswell, among others, has noted that this is especially true of teachers. In "Children's Abilities in Topographic Map Reading" (in Map Design and the Map User: Cartographica Monograph No. 2) he puts it succinctly: "I suspect that there is a gross oversimplification in the minds of teachers of just what is involved in reading a map". The elaborateness of the technologies aside, I think this is likewise true of professional cartographers.

11. W. R. Tobler's "Medieval Distortions: The Projections of Ancient Maps", Annals of the Association of American Geographers, June 1966, is a distinct and laudable exception. That he understood the significance of making comparisons along a single dimension is made clear in his concluding remarks where he generalizes the strategies

developed in his paper. If any justification were needed for my decision to use landform relief as a dimension of comparison as useful as Tobler's it could be found in the passage quoted by Brown, op. cit., 303-304, from the resolutions passed by the Second International Conference on the International Map: "There is perhaps nothing which more strikingly distinguishes... maps of one nationality from another, than the manner in which valleys, hills and mountains are represented, whether it be by drawing the shapes of mountains, as in Chinese maps, or by covering the paper with dashes, sometimes called hachures, which show which way the water runs, or by horizontal lines that delineate the contours of the slopes, or by shading with high light and shadow, as if the map were a relief model".

12. Norman Thrower, Maps and Man, Prentice-Hall, Englewood-Cliffs, 1972, 78.

13. Edward Lynam, The Map Maker's Art, The Batchworth Press, London, 1953,38.

14. Arthur Robinson and Randall Sale, Elements of Cartography, Third Edition, John Wiley and Sons, New York, 1969, 172.

15. David Greenhood, Mapping, (Phoenix Science Series), The University of Chicago Press, 1964, 74-75.

16. Bagrow, op. cit., 25-28; Mary Elizabeth Smith, Picture Writing from Ancient Southern Mexico: Mixtec Place Signs and Maps, University of Oklahoma Press, Norman, 1973; John Spink and D.W. Moodie, Eskimoe Maps from the Canadian Eastern Arctic: Cartographica Monograph No. 5; Donald Wise, "Primitive Cartography in the Marshall Islands," The Canadian Cartographer, June 1976.

17. Bagrow, op. cit., 27.

18. Spink and Moodie, op. cit., 16.

19. Ibid., 16-17.

20. Ibid., 34.

21. This is a situation that is undoubtedly going to change. The materials treated by Smith, op. cit., have been known fairly well for three-quarters of a century, but are just now being recognized by cartographic historians. Eulalia Guzman, for example, writing for Imago Mundi in 1938 under the title "The Art of Map-Making Among the Ancient Mexicans," ignored them--if he knew of them--entirely. Similar illumination to that provided by Smith should be soon forthcoming from China, India, even the United States, where the Amerindian cartographic heritage has been shamefully neglected. In

spite of these anticipated advances, the argument put forward here about the origins of hill-forms should stand, if with modification.

22. Bagrow, op. cit., 27, does note that the ancient cultures of Mexico "were highly developed" but this is just after having remarked that "many savage peoples have shown some skill in drawing maps." The linkage, however unforgivable, was more typical of his times than of Bagrow. Thrower's remark is on page 10 of his Maps and Man, op. cit.

23. Smith, op. cit., passim; Donald Robertson, Mexican Manuscript Painting of the Early Colonial Period: The Metropolitan Schools, Yale University Press, New Haven, 1959; Donald Robertson, "The Mixtec Religious Manuscripts," Howard Cline, "Colonial Mazatec Lienzos and Communities," and Alfonso Caso, "The Lords of Yanhuitlan," all in John Paddock, ed., Ancient Oaxaca, Stanford University Press, Stanford; the Codex Nuttall has been recently published, in color, as The Codex Nuttall, Dover Publications, New York, 1975.

24. Smith, op. cit., 21.

25. Ibid., 39.

26. Ibid., 92.

27. Ibid., 94.

28. Ibid., 93-96 et passim; Bagrow, op. cit., Plate III.

29. Bagrow, op. cit., Plate V.

30. Wright, op. cit., 252-253.

31. This is a summary of Lynam, op. cit., 38-41. There was a third parallel development from hand-drawn manuscript maps, through woodcuts, to copper engraving.

32. R.A. Skelton, "Cartography," in A History of Technology, op. cit., Volume IV: The Industrial Revolution, 611.

33. D.H. Fryer, "Cartography and Aids to Navigation," in A History of Technology, op. cit., Volume V: The Late Nineteenth Century, 439.

34. Robinson and Sale, op. cit., 177.

35. Ibid., 173.

36. Erwin Raisz, Principles of Cartography, McGraw-Hill, New York, 1962, 88-89.

37. A portion of this map is illustrated in Figure 2. My slightly mutilated copy bears no indication by or for whom it was created. I presume it was manufactured here for Japanese tourists, but my letters to a number of the retailers noted on the map have borne no fruit.

38. While probably not representative of anything, the sketch maps discussed were drawn by the following: small town Puerto Rican kids between 7 and 21; small town Mexican kids between 13 and 18; junior high students from Massachusetts and North Carolina; high school students from the eastern half of the United States, from Massachusetts, and North Carolina; college students from Puerto Rico, Massachusetts, Kansas and North Carolina; and adults, both in adult education courses and unassociated with school, from the same places, including a number of secondary school teachers.

39. Frank Klett and David Alpaugh, "Environmental Learning and Large-Scale Environments," in Moore and Golledge, op. cit., 121-131. By "large-scale" the authors mean large, or small scale. David Stea has reproduced two other maps from the San Fernando set--in color!--in his Environmental Mapping: Unit 14, Art and Environment, A Second Level Interdisciplinary Course, The Open University Press, Milton Keynes, England.

40. Denis Wood, Fleeting Glimpses: Adolescent Images of that Entity Called San Cristobal las Casas, Clark University Cartographic Laboratory, Clark University, Worcester, Massachusetts, 1971.

41. Robinson and Sale, op. cit., 172.

42. Ibid., 173-74.

43. Nearly half of these drawing were collected by Betty Murrell and her colleagues Greg Wall, Scott Stone and Jeff Schoelkopf, undergraduate students in the School of Design at North Carolina State University at Raleigh. Others were collected by Dick Henry, Nann Boggs, Aileen Kennedy and others, also undergraduates at the same school. Nearly half the drawings were collected by me. All were collected under my supervision.

44. For the ability of kids to produce such drawings see Roger Hart, Aerial Geography: An Experiment in Elementary Education, Unpublished MA Thesis, Clark University, Worcester, Massachusetts, 1971; J.M. Blaut, Studies in Developmental Geography, Place Perception Research Report No. 1, Clark University, 1969; J.M. Blaut and David Stea, Place Learning, Place Percep-Research Report No. 4, Clark University,

1969; J.M. Blaut, G.F. McCleary and A.S. Blaut, "Environmental Mapping in Young Children", Environment and Behavior, June 1970; and the bibliography in Carswell, op. cit.

45. The work of this school of structural developmentalists is brilliantly summarized in Roger Hart and Gary Moore, The Development of Spatial Cognition: A Review, Place Perception Research Report No. 7, Clark University, 1971. A Shorter version is included in Downs and Stea, Image and Environment, op. cit.

46. In his "Neurophysiology of Cognition" (in Paul Garvin, ed., Cognition: a Multiple View, Spartan Books, New York, 1970), Humberto Maturana provides the neurophysiologic foundation for the organismic arguments of Werner and company.

47. Bruner et. al., Studies in Cognitive Growth, John Wiley and Sons, New York, 1966. Especially relevant are the first two chapters by Bruner and the final three by Maccoby and Modiano, Greenfield, Reich and Olver, and Bruner.

48. Heinz Werner and Bernard Kaplan, Symbol Formation, John Wiley and Sons, New York, 1963, passim.

49. Bruner, op. cit., 2 and 6.