

CHAPTER 17

Imagine the following physical equipment: a blackboard on which is drawn a representation of the earth's surface, a portable bulletin board with the opaque cork board replaced by a plate of glass and this contraption placed about twenty feet in front and parallel to the blackboard. In addition, imagine a large number of strings, each string having one end glued to the blackboard and the other end glued to the plate of glass so that it is not difficult to imagine that each point on the blackboard map has a string connecting it to each point on the glass. The strings establish a one-to-one correspondence between the blackboard and the glass. The particular relationships of the set of points at the blackboard end of the strings to the set of points at the glass end of the strings determines the transformation or, the geometric rules under which we are constrained to move from one surface to another. There are severe restraints on what sort of rules of translation can be adopted. For instance, we could have the strings cross each other in a chaotic entanglement producing a random transformation. This would create a situation in which every spatial property on the blackboard is destroyed by the transformation to the glass. This is not a promising spatial prospect...

. . . WILLIAM BUNGE
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I

As must be clear, despite the success of the analysis performed in the last chapter, it barely scratches the surface of the map. That is, we were able to discuss three rivers and one street using that technique. Needless to say, this will not do. A map is much more than any element, no matter how central or prominent that element is. Furthermore, the space of the map may conform to certain characteristics around a given feature and yet conform to an entirely different set of characteristics elsewhere on the map surface. The deformations of the rest of the map surface may or may not follow from the deformation of a given feature. Is there any way to get an idea of the character of the map surface as a whole, without grappling with the question of scale?

Indeed there is just such a technique available. To my knowledge the technique was first applied to mental maps in a report on a project utilizing sketch maps of the campus of Clark University to investigate the impact of a move on the part of the faculty from one set of offices to another (Beck, Cohen, Craik, Dwyer, McCleary, and Wapner, in press). In theory the technique is quite simple, although its assumptions demand investigation, but in practice the technique is somewhat demanding. However, its use in the study mentioned above provided amazing and fruitful results and consequently it has been employed, probably more fruitfully, in the study at hand.

Reference to Figure 17.0 will facilitate discussion of the technique. Here is the comparison of the sketch maps with a standard map. Whether or not the standard is a veridical representation of the real world is irrelevant. No matter what it represents, it provides a standard against which to compare all of our sketch maps. The standard maps used in this case were recent large scale maps of London, Rome and Paris. These were reduced in size to six by nine inches and a rectangular grid was laid arbitrarily upon them. It is important at this point to understand the characteristics of this grid: 1) all lines crossed each other at right angles; 2) all line segments were of equal length in either direction; 3) each compartment was a perfect square containing an area of one square inch; 4) all vertical lines were parallel and all horizontal lines were parallel. The grid may be seen in reduced form in Figure 17.0.

This grid bears an arbitrary but precise relation to the city over which it is imposed, similar to the relationship between the world and the somewhat arbitrary grid of latitude and longitude lines imposed upon it. As a result of this imposition, each point, line or area in the city may be assigned a specific set of coordinates which define it uniquely.

Thus, the back entrance of the Ecole Militaire in Paris bears the coordinates H3.5, V2.5 and no other point in Paris bears these coordinates.

Now, if the relations that obtain between the things mapped by the kids are isomorphic to the relations that obtain on the standard map it will be possible to produce an identical grid on a sketch map. To the degree that the relations between the things mapped by the kids differ from the same relations on the standard map, the grid will be deformed. Vertical and horizontal lines will not cross at right angles, compartments will not form squares, line segments will be of varying lengths, and so on. In Figure 17.0, the points in the lower row represent the same points shown in the upper, or standard situation. Those in the lower are representative of the relative locations of the points that obtain on a hypothetical sketch map. Connecting the points in the standard situation results in a right-angle grid, while connecting those in the sketch situation results in a grid that differs markedly from the right-angle example. The difference between the grids may be measured using a variety of devices.

The process of drawing the grid on the sketch map is worth describing, both for a better understanding of the grids that are to be displayed, and for the benefit of anyone wishing to repeat the process. However, certain assumptions must be made about the nature of the map surface before it is possible to proceed. These assumptions derive from the discussion of the nature of the map surface in Chapter 13. There it was shown that the map surface is no more inherently "spatial" than it is "temporal," that is, to the extent that the map is a trace of a space-time event, it displays spacio-temporal relations, as opposed to either "spatial" or "temporal" relations alone. This realization allows us to see the map as isomorphic to the experiences inherent in gathering information to be mapped, and makes it impossible to view the map as merely the display of "spatial relations," whatever those may be. Further, our argument will draw heavily on our ability to reduce the triadic spatial relation "between" into a pair of spacio-temporal dyadic relations, as discussed in Chapter 13.

The Assumption of Spatial Continuity. It is a common assumption that space is continuous in nature, that is, that space does not consist of discrete "hunks" but rather that it is a continuum, as it were, from one part of space to the next. However, the General Theory of Relativity and certain recent discoveries in quantum mechanics tend to cast some doubt on the general validity of this assumption, suggesting that the nature of experience (and of space and time) may be discontinuous, that a certain state may exist for a time, and then be replaced by a

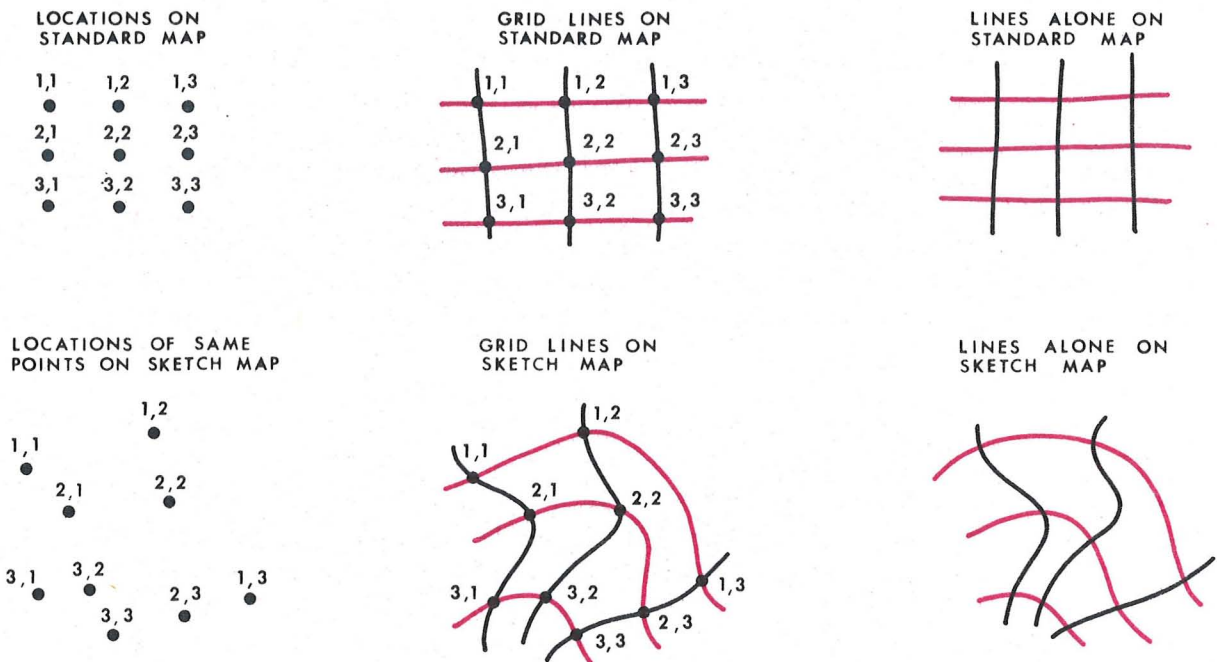


Figure 17.0 The relationship between the standard right angle grid and the grid of a hypothetical sketch map.

finitely different state. Considering these issues Russell says that "continuity of motion, which had always been assumed, appears to have been a mere prejudice" (Russell, 1964, 833). If this is the case, our customs of interpolation and extrapolation lack theoretical validity, and must be disallowed, or at any rate seen as practices founded on purely assumptive grounds. On the other hand, the success of the General Theory of Relativity in these areas is not complete (see Adolf Grunbaum in Smart, 1964, 313, for a summary of the failures of the General Theory) and even Russell is constrained to remark that "the philosophy appropriate to quantum theory has not been adequately developed" (Russell, 1964, 833). This being the case I suggest that we continue to employ tools such as interpolation that are based on the assumption of spatial continuity in general.

If there are questions about the continuous nature of experience generally, there are many more questions that could be raised about the nature of mental space and sketch map space in particular. For example, the mental space of dreams does not seem to be continuous, but rather discrete, and in fact it is partially the discrete character of dream space that allows us—demands us—to call it dream space. However, sketch maps are not dream space, and since the question of the relationship between the discontinuous nature of dream space and other mental space will be here begged, we are going to assume that the space represented on the sketch maps is in fact continuous in nature. We shall assume—whatever the shape of sketch map space—that it flows continuously across the surface of the map without finite breaks. Thus we may interpolate and extrapolate in sketch map space.

The Assumption of Navigational Sufficiency. Where our first assumption established the continuous nature of sketch map space, this assumption will establish the nature of the shape of sketch map space and allow us to designate an appropriate geometry for the examination of this space. Essentially this assumption says that sketch map space is a sufficient representation of the environment in question to allow the sketcher to navigate in said environment. To rephrase this assumption, it means that the grid produced by the sketch map obeys the following laws: first, lines parallel on the standard grid remain parallel on the sketch map grid; second, if grid line 2 appears between grid line 1 and 3 on the standard map, it so appears on the sketch map.

Let us consider the implications of this assumption. A person setting out to walk through Paris along an arbitrarily designated line might first encounter the Boulevard Jourdan, the Parc Montsouris, and the Boulevard General Leclerc, then pass to the west of the Jardins de Luxembourg, cross the Seine, pass between the Tuilleries and the

Louvre and so on. We shall consider each of these encounters as a point and note that they can be arranged in a linear sequence such that the second encounter comes between the first and the third, and that the third comes between the second and the fourth and so on. (Basically we are disintegrating the spatial sequence into a series of dyadic pairs as set forth in Chapter 13.) Each of these points can be numbered as follows:

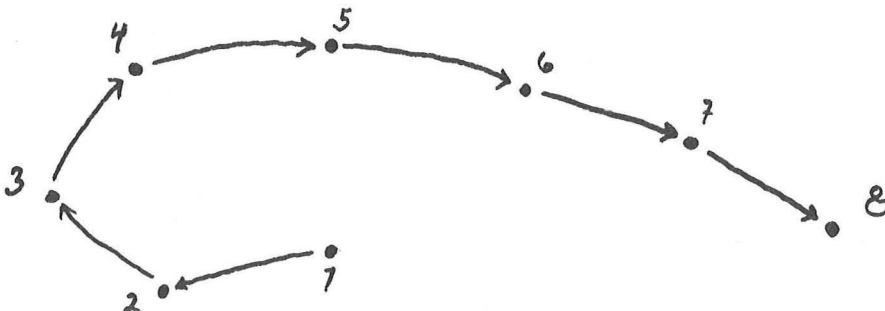


This sequence as drawn has spatial relations to be sure, but also has the temporal or causal sequence in which they were encountered on the arbitrary walk described above.

Now consider the location of these points as found on a hypothetical but typical sketch map.

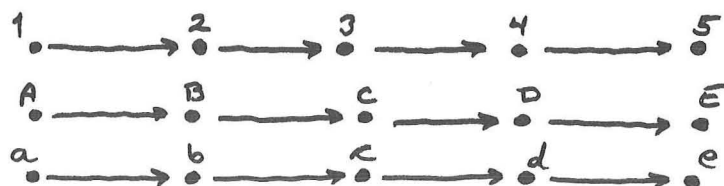


All that our assumption of navigational sufficiency says is that a kid drawing this map is nonetheless able to walk the route described above even though the points are not ostensibly arranged on the sketch map as they are on the standard map. On the standard map the walk from the Boulevard Jourdan to the Louvre appears as a simple straight line. The standard map was made according to a standard projection. Is it necessary that the student use the same projection? No. All that is necessary is that he be able to complete the walk using his projection. That is, we must encounter point 2 between point 1 and 3 in the sketch map as on the standard map. Can this be done with the sketch points? Certainly:



Our simple, though not straight line, solution is only one of many potential solutions for this particular set of points. What is important is that in both the sketch set and the standard set, the nature of the spacio-temporal experience is similar. Both sets are sufficient for the navigation of the Parisian environment. Neither the standard set nor the sketch set are real. Both are representations on a two dimensional surface of an infinitely more complex multidimensional situation. The standard straight line may appear more elegant, or it may not, but it is no more real.

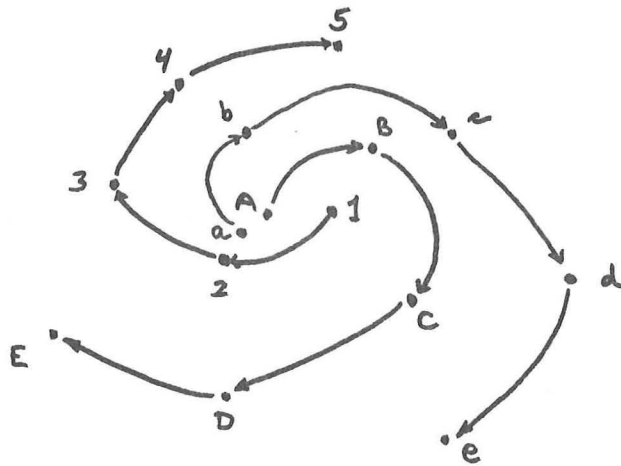
Now consider three parallel walks on the standard map. They could be represented in the following manner:



The same set of points might appear on the sketch map as follows:

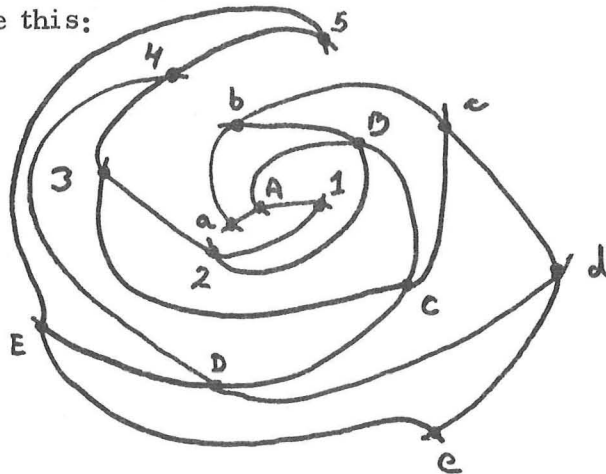


This set of points unquestionably looks chaotic when compared with the order of the standard set. The assumption of navigational sufficiency allows us to connect the points in the following manner:



While this arrangement may not appear as elegant as the standard arrangement, both arrangements are equally sufficient, and that is what is important. (It might be objected at this point, where I have employed our law concerning parallels, that the three lines sketched above are not in fact parallel. Quite the contrary is true, for the Euclidean axiom of parallels simply states that there is exactly one parallel (that is, a line which has no point in common with the first line and such that both lines are contained in a plane) to a line through a point not on the line, and it is in exactly this sense that the lines sketched above are parallel and in this sense only.

Obviously it would be possible, in the standard case, to connect point 1 with point A with point a, and so on; with points 2, B and b; 3, C and c; and so on, until we found ourselves with the completed standard grid. The same can be done with the sketch grid which would finally look like this:



I have omitted the arrows for the walks this time since it is obviously possible to make the walks in either direction (theoretically). Nor will I bother to draw the diagonals that could be drawn *et cetera*. The two sets of points—standard and sketch—are topologically isomorphic and that is sufficient to navigate by. At this point I wish to discuss the manner in which our assumption of spatial continuity comes into play.

Suppose for a moment that in the preceding illustration only points labeled 1, 2, 3, 4, 5, and those labeled a, b, c, d, e, existed. That is, suppose that the sketcher had omitted all those points labeled A, B, C, D, E. Were this the case I would have proceeded exactly as I have for the points displayed, with this exception: I would have been justified in interpolating the existence and position of the missing line. Its existence is a function of the continuous nature of the space in question, and its position would be interpolated to correspond to the position of the same line on the standard map—midway between the numbered line and the lower case line.

In the end our assumption of navigational sufficiency amounts to no more than assuming that the kids sketching the maps are capable of navigating through the environments of London, Rome and Paris with the information displayed on their maps. It is likely that our failure to understand this in the past resulted from our unwillingness to consider the possibility that the sketch mapper was not distorting the world in his map but rather projecting it according to a personally consistent and useful system. There is, of course, no reason that he should use any of the multitude of mathematical projections that have been devised by professional cartographers. There is nothing to have prevented him from representing his environment using any convenient system, no matter how strange such a projection might appear to our Mercator-Albers-Miller-Lambert jaundiced eyes. All that is necessary for any map is that it be useful to an individual, to a group, to any number of people, and by useful I do not now mean to imply that it be even navigationally useful, so long as it fulfills some felt need.

To understand the role these assumptions play in performing our grid transformation analysis, it is only necessary to describe the process of locating the grid on any sketch map. You take a sketch map and assign to each item on the map the coordinates that that item would have on the standard map. Thus, the Eiffel Tower on the standard map is located at H3, V2, so we assign H3, V2 to the Eiffel Tower that appears on the sketch map. We do this with each and every item on the sketch map. When all the coordinates have been transferred to the sketch map, we regard them as control points and begin to draw our grid system, treating the grid lines as isarithms (see Figure 17.0).

It may be objected that isarithm is not the appropriate word but I rather feel it is. An isarithm is a line connecting points of equal value. The value that all the points along one of our grid lines have in common is that of equidistance from the edge of the standard map. Thus, all the points along grid line V3 are exactly equidistant from the edge of the standard map. Furthermore, the use of the term isarithm assumes that higher and lower values cannot be found next to each other without the incidence of intermediate values. Thus, although on a given sketch map we find a point located on grid line 2 immediately adjacent to a point located on grid line 5, we assume that passing between these two points are grid lines 3 and 4.

The treatment of the grid lines as isarithms results directly from our assumptions of surficial continuity and navigational sufficiency. Actually, our grid lines become analagous to contour lines, as a glance at the following sketches will make apparent. To the extent that the grid lines are analogous to contour lines, so the grid transformations that comprise the results of this analysis are analogous to topographic maps. Has this analogy any value?

It could have great value. The study of topography has developed an interesting and extensive vocabulary that we may borrow from freely and apply to the study of mental map surfaces. It is particularly relevant in a study such as this, which by virtue of collecting maps through time, is able to take a genetic viewpoint. The basic mental map-geomorphic analogy is quite rich. Thus novel experiences may be compared with the tectonic activity of the earth's crust, the effects of memory compared with the process of erosion, and many geomorphic features compared with many features of the mental map surface. Consider the analogy of the grid line described a couple of paragraphs back. Several proximate grid lines, the result of two environmentally distant items being placed next to one another, can be understood to represent a steep slope or cliff. Consideration of these grid lines as a perceptual or cognitive cliff gives us a handle on this phenomenon. It might be designated a p-cliff (for perceptual-cliff) and its existence would imply the same sorts of things about the mental map that the existence of a real cliff implies about the nature of topography.

Further examples of analogies are legion:

In terms of the grand scale of geological processes there are two fundamental classes of landforms. First, there are the original crustal masses raised by the internal earth forces and by volcanic eruption. They comprise the initial landforms.

Second, there are the landforms made by agents of denudation. Because these follow the initial forms and occur in orderly sequences, they are called collectively the sequential landforms. (Strahler, 1965, 228)

In terms of our study the initial p-landforms are the mental maps whose traces we have been considering. Volcanic eruption is not too violent a term to compare with the effects of a summer tour to Europe on the mental map of an individual. The sequential p-landforms, components of mental maps that develop under the impact of time once the trip has ended, gradually denude the initial p-landforms. And as is true in the geologic case, certain portions of the initial p-landforms will prove to be more resistant to p-erosion than others, leaving sharply etched remnants on an increasingly smoothed surface. By studying these "memorials" in a geologic fashion, it might be possible to reconstruct the initial p-landforms, even in the absence of specific information about the nature of the surface.

Any landscape is really nothing more than the existing stage in a great struggle or contest. The internal earth forces spasmodically elevate parts of the crust to create initial landforms. The external agents patiently keep wearing these masses down and carving them into vast numbers of smaller sequential landforms. (Strahler, 1965, 228)

Strahler's words apply equally well to the mental landscape. This is one way in which the grid transformation analysis enriches our ability to discuss the characteristics of the mental map surface.

There is, of course, a second, even more obvious analogy that can be drawn between the grid lines and the lines of latitude and longitude. This analogy has been implied through much of the preceding discussion. Thus it is that we become able to discuss with cartographic precision the varieties of projections employed by the kids in drawing their sketch maps of London, Paris and Rome, and by extension to some awareness of the probable projections employed by the mind in storing locational information. Waldo Tobler has provided the rationale for our approach in his attempt to determine map projections employed by map makers of six and seven hundred years ago (Tobler, 1966). In this study he used a technique practically identical to ours, assigning contemporary coordinates to items portrayed on these ancient maps, drawing the grid employing these coordinates, and subsequently trying to


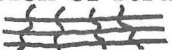


identify the nature of the projection used in drawing the map in the first place.

The following comments refer only to the estimation of the map projection implied by the ancient mappaemundi and portulan charts. The maps ...under investigation do not contain any indication of the terrestrial graticule of latitude and longitude. This has led some students to conclude that the maps are not based on any projection...Certainly the lack of graticule does not imply the absence of a projection...It would be correct to say that the map is not based on a map projection only in the sense that the cartographer involved was not consciously employing a map projection. But, as one learns from any elementary work on map making, every map requires a map projection. The ancient maps therefore are implicitly referred to some map projection... The fact that the implied projection does not match either of two specified contemporary projections does not prove that the chart is not based on a map projection; such a conclusion can never be drawn if one accepts the notion of an implied map projection. The search must continue for a map projection, which may be any one of the several hundred now known, or may be one which is completely unknown today... An obvious approach is to attempt to sketch the lines of latitude and longitude on the map, as estimated by identification of locations shown thereon. Examination of the graticule, its curvature and so on, should provide hints as to a reasonable family of projections. (Tobler, 1966, passim)

At this point Tobler's interests and our diverge since he becomes concerned with estimations of increasing accuracy throughout the history of cartography. Of course, we are not using the earth graticule as a basis of comparison, but rather an arbitrary grid analogous to the earth graticule. Nor am I concerned with establishing the type of projection used by an individual mapper, but rather with the varieties employed and the growth of projective consensuality through time.

In an earlier article Tobler wrote:

The desire for a classification of map projections stems from the fact that an infinite number of distinct projections are possible. Hence, the fundamental problem in classifying map projections is the partitioning of this infinite set into a comprehensible and useful finite number of all-inclusive and preferably non-overlapping classes. (Tobler, 1962, 167)

The classification devised by Tobler resulted in four basic classes of projections. I will not delve into the reasoning behind his classification but simply adapt some of its salient features to my purposes. The fourth class was considered by Tobler to be the simplest. As a glance at the results farther on in this chapter will show, it is also the least common in the mental map situation. Class four is characterized by perfectly straight lines in the rectangular situation: . Tobler's third class relaxes the criterion of straightness in the meridians, while retaining it in the parallels: . For class two Tobler reversed the criterion of class three producing a grid like this: . In class one, both the parallels and meridians are curved: . (All the other categories are actually special cases of this class, the most general.)

There are other systems for analyzing map projections into categories of varying systematic quality and character. Robinson, for example, has provided ten criteria that can be used to classify maps based on deformational properties (Robinson and Sale, 1969, 221-244). He also discusses a classification based on constructional properties (Robinson and Sale, 219-220). All three of these classifications (Tobler's grid morphological, and Robinson's deformational and constructional property approaches) are insufficiently general for our purposes, in that all are concerned with the geometry of projecting a sphere onto a plane, an issue that may or may not be relevant in the mental mapping case. Inasmuch as Tobler's deals with the characteristics of the apparent grid (and grids are what we have) and inasmuch as his results in the smallest number of classes, it is Tobler's system to which we shall allude. Nonetheless, Robinson's classifications have some merit and could be employed with value.

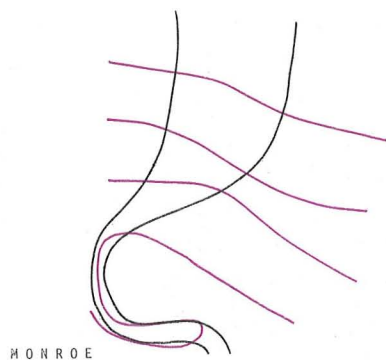
At this point we are ready to examine the results of the grid transformation analysis. Bear in mind, however, what we have covered in this introductory note: we have made two assumptions about the sketch maps, and have discussed two sets of language with which to deal with our results. The two assumptions are those of surficial continuity and navigational sufficiency. The two languages are those of geomorphology

and cartography.

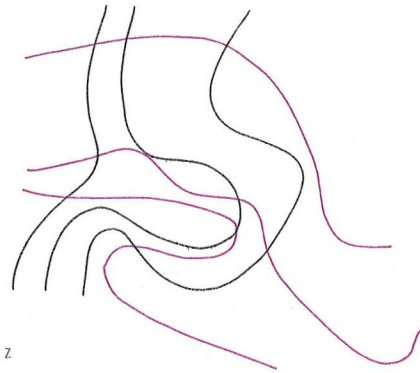
II

Figure 17.1 (A, B, C and D) is from any point of view a rather remarkable figure. Casting my eye over the incredible range of variations worked on a simple right angle grid I am reminded of the Bunge quote opening this chapter: it's a bleak spatial prospect. Of the twenty-six transformations displayed nearly all fall rather neatly into Tobler's most general class of projections, while the application of Robinson's simplest criteria must look like a bit of a pipe dream. Nonetheless, some categorization is immediately apparent and I shall divide the projections into four classes based on the degree to which they approximate Tobler's most general and most specific class. Thus those maps that nearly approximate a projection consisting of a straight line grid have been separated from those showing only local variations in such a grid, those showing excessive variation from such a grid, and from those showing distinctly non-straight line grids in both dimensions. Basically I have two classes: straight line grids and non-straight line grids, with two intermediate classes. Since the existence or non-existence of these classes must be determined by whether members of each class bear greater resemblance to other class members than they do to members of other classes, it will be necessary to place each grid transformation in its class and to compare it to other members of that class and to maps in other classes.

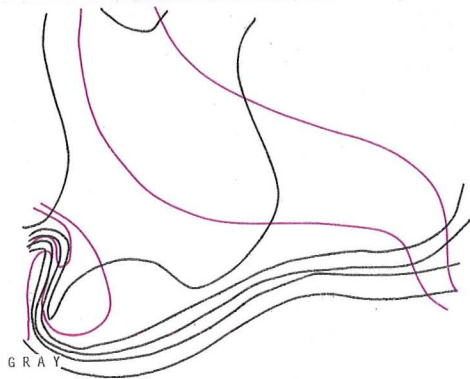
The first class to be considered contains all those maps entirely lacking straight line grids. For the first London maps this class includes the projections of: Pagan, Gray, Cruz, Gordon, Lincoln, Fisher, Baker, Heller and Casyk. Each of these projections is characterized by significant curvature of substantial portions of the space of London relative to the reference (or right-angle) grid system. Let's look at a couple of these in detail to see what this implies. Take the projection used by Nybia Pagan (north is to the right on her map). At first sight her map, from which this projection was inferred, appeared to be less than reasonable. Basically it consisted of two separate constellations of points and lines. One of these constellations centered on Euston Road with the other on the Thames. (Refer to Chapter 7.) The Thames was south of Euston Road and consequently overall the map was veridically oriented. The problem was that all the points connected with Euston Road that belonged south of Euston Road were located north of it, or in other words, points that belonged (on the reference map) between Euston and the Thames were found to be not so located. It would seem that Nybia believed that walking down Tottenham Court Road from Euston led her north towards Scotland, instead of south towards the Thames.



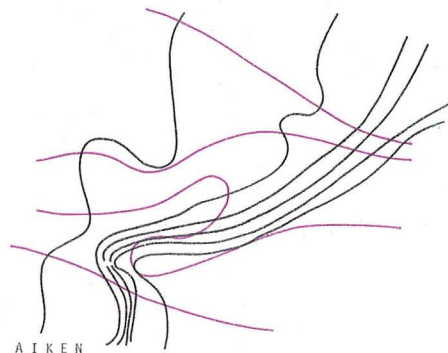
MONROE



LENZ



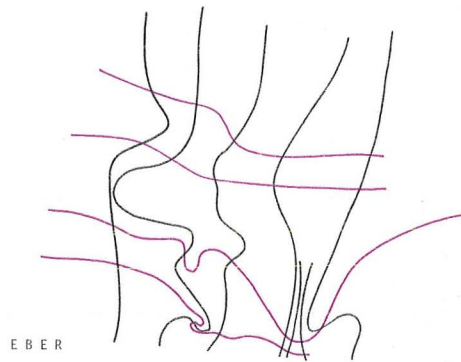
GRAY



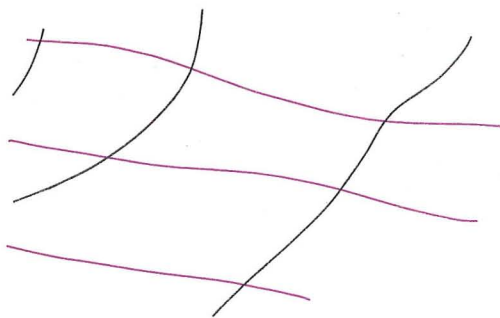
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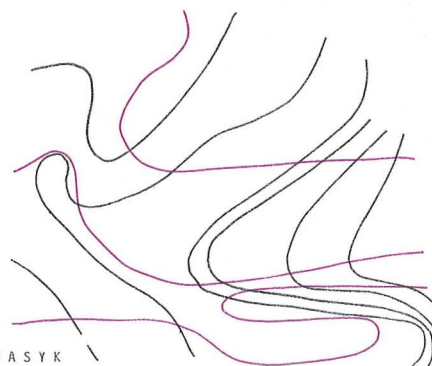
JAECKEL



EBER

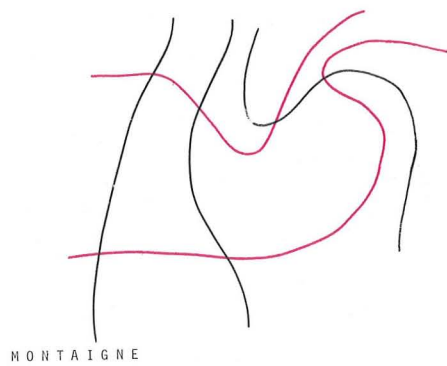


ABRAMS

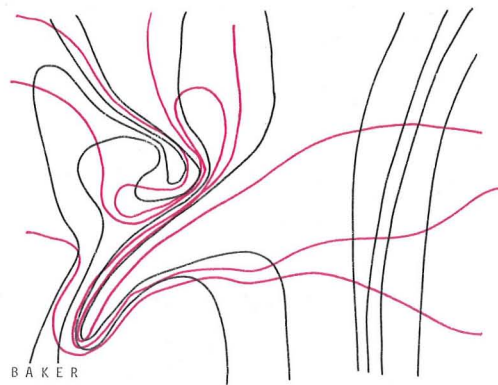


CASYK

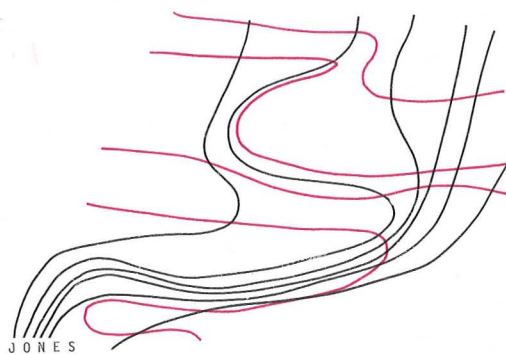
Figure 17.1A Transformations of the first London maps.



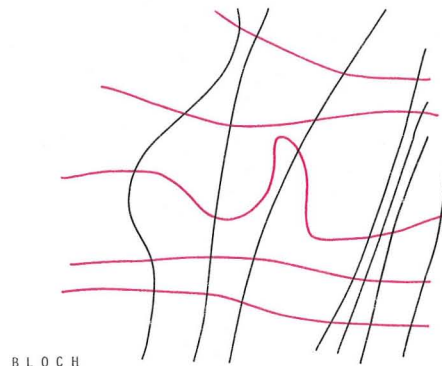
MONTAIGNE



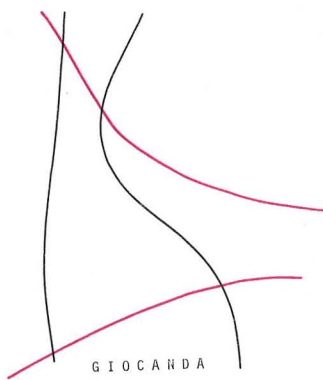
BAKER



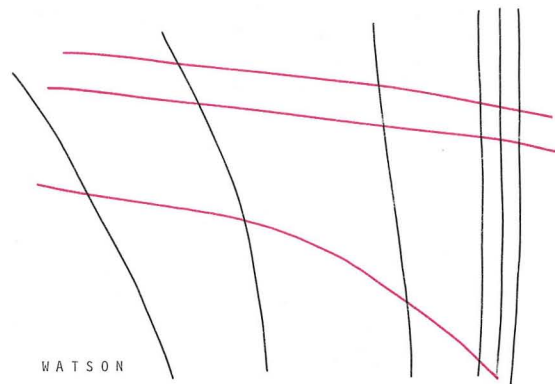
JONES



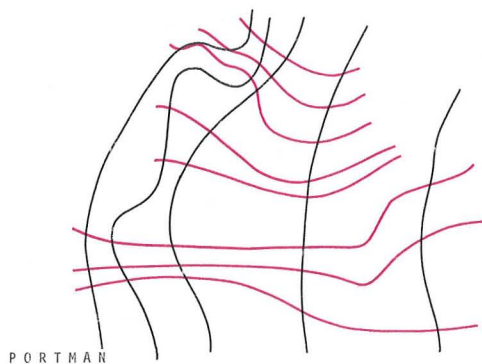
BLOCH



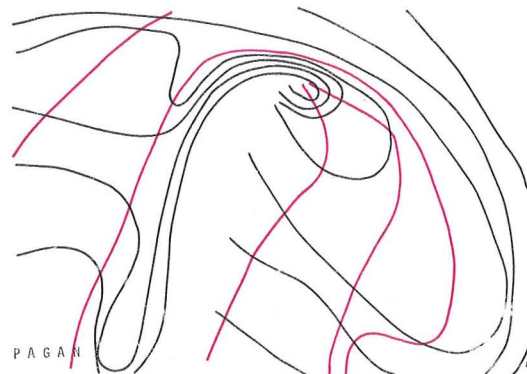
GIOCARDA



WATSON



PORTMAN



PAGAN

Figure 17.1B Transformations of the first London maps.

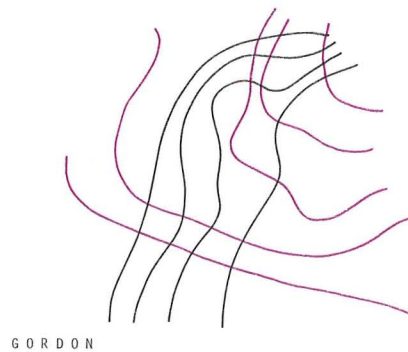
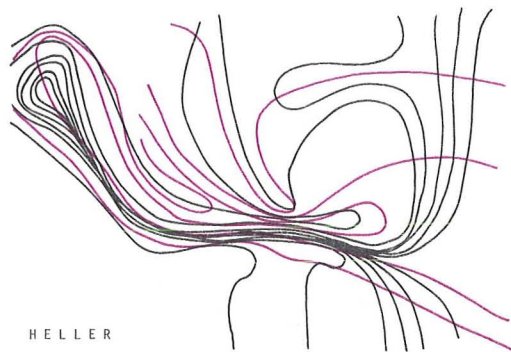
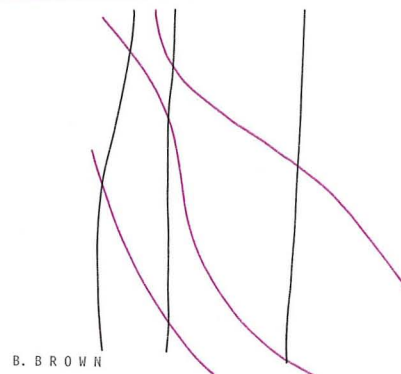
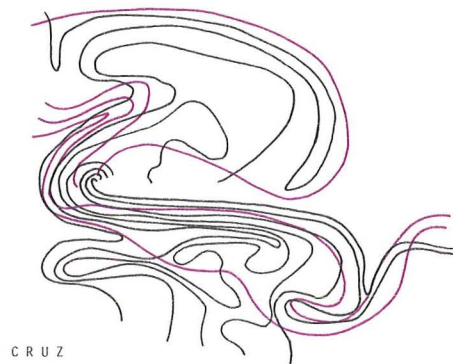
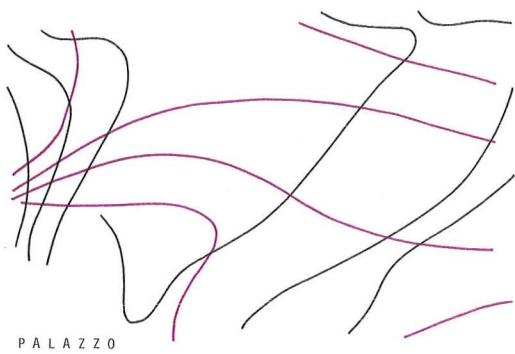


Figure 17.1C Transformations of the first London maps.

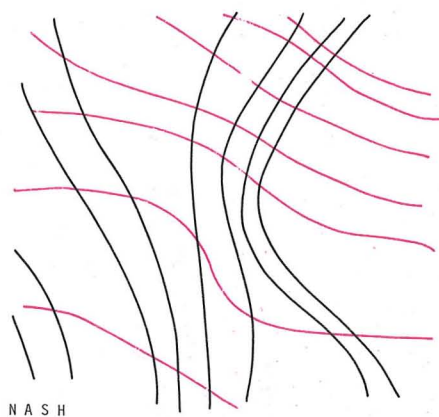
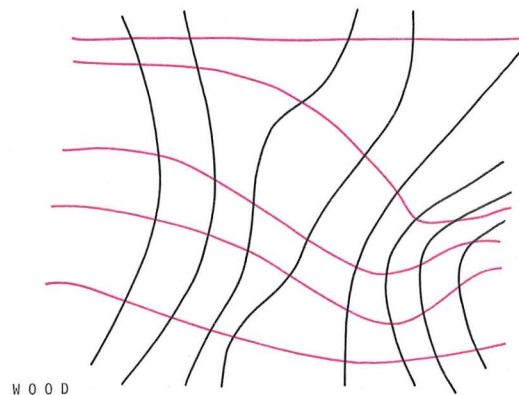


Figure 17.1D Transformations of the first London maps.

Now let us reconsider the assumption of navigational sufficiency. If Nybia had actually believed that London were organized as shown on her map she would have been unable to move, or would have been constantly getting lost. Thus to reach the Thames constellation she would have had to proceed down Tottenham Court or some parallel road. But on her map these lead north away from the Thames. It is an impossible situation. It is also easy to resolve. Note that the gorgeous curves in her projection do a very simple thing. In effect they flip the entire Euston constellation. If she walks down Tottenham Court Road now, she will head initially north and then curve west and finally south before she ties up with the Thames constellation. In effect, her map is confused in respect to space that is not curved, but not confused in respect to curved space (curved only in the sense that her grid lines are not straight). Is there any reason not to project Nybia's map as we have done? None. Are there any reasons for so doing? Yes. They make the map align with the behavioral outputs, that Nybia did not get lost and that Nybia went from Euston to the Thames with some frequency.

A projection exhibiting generic similarities is that of Susan Lincoln. Viewed as a projection in uncurved space, Susan would be unable to move or Susan would be getting lost with regularity (she did get lost once). A projection in curved space resolves these difficulties. The projection shown for Erica Cruz presents a combination of Nybia's and Susan's methods. Thus, Erica shows Tottenham Court Road heading north from Euston with respect to the Thames and consequently her projection shows the great Pagan curves. However, the minor disturbances that transform Susan's grid also show up on Erica's map. If we now remember the strategy Erica employed in drawing her map we can explain some of the variation. On this first map Erica drew everything she had heard of in London, whether or not she knew its location. This explains the Lincoln variations, but since the Pagan curves remain through subsequent Cruz attempts, we must consider them organic attributes of her projective system.

Our second class of mappers includes Jones, Monroe, Palazzo and Jaeckel and George Aiken. In these projections there is extensive curvature of space and yet the curvature does not affect the entire map surface. In our first category the whole projection shows such transformation. A perfect example of this is in the projection used by Agatha Jones. In her case half of the space of London is projected on a straight line grid with local disturbances, while the other half shows extensive curvature which results from the location of the Tower of London in close proximity to something like Parliament. Since this is a common cause of transformations it demands comment. It shows up in this class on the projections of Aiken, Jackel and Palazzo, though in her

case the result has not been the cramming together of lines in between Parliament and Westminster Abbey (Vittoria's map has north at the bottom). In most cases, however, the movement of the Tower vis-a-vis Parliament results in a distinct p-cliff. This p-cliff may be viewed as a steep escarpment up which perceptual movement is arduous. Thus we can skim across the p-plain of London west of Parliament (resulting in even separation of grid lines) but we bang into a perceptual barrier in trying to visualize London east of this point. London east of Parliament (and north of the Thames at this point) can be seen as a p-plateau introduced by a p-escarpment. In the case of Jaeckel, the p-escarpment has been worn away to a mere p-resistant finger, apparently impervious at this point to the effects of experience.

Our third class of mapper contains projections that begin to approach a straight line right-angle grid. Included here are: Montaigne, Giaconda, Lenz, Mayo, Eber, Bloch, Portman, and Nash. Some of them may seem only slightly removed from the last class, and yet in each instance the case can be made for the purely local character of the disturbance. Thus in the significantly curved example of Therese Montaigne, a single point is at work, which does not cause the grid angles to be other than 90° , nor seriously disturb the parallelism of the lines. It is not a straight line, right-angle grid, but in comparison to those we have seen it is a quantum leap forward. Similar remarks might be made about the projection used by Giaconda, but these would apply to none of the other members of this class. To a map, they give an overall impression of having been projected onto a straight line right-angle grid within which occur minor aberrations. Take the projection used by Bloch. In the center of the projection is a wild curve. That it is not shown in both sets of grid lines, means that it is incorrectly located vis-a-vis the standard grid in only one dimension. In fact, the line draws Piccadilly Circus south of Oxford Road where it belongs. That other parallel lines do not follow the leader in the chase for Piccadilly results from the fact that they are securely anchored on other business more properly theirs. Essentially, Miss Bloch has produced a replica of the standard grid with the sole exception of an aberrant Piccadilly Circus. The p-cliff on Mayo's projection results from the location too far to the south of a pair of places. An attached note says of them: "I don't know where they go—but they go together."

Finally we look at the class containing serious approximations of the reference grid. For our purposes these are straight-line right-angle grids. Let's not forget that these maps were the first ones drawn of London and that they were drawn free-hand. The grids in question are those produced by Abrams, Watson, Bill Brown, Pierce and Wood. As the general paucity of grid lines on these projections compared with

previous classes will make clear, the right-angle grid was achieved by mapping a smaller part of London than was attempted by the rest of the kids, a part that was well known and clearly understood. The two exceptions are the projections produced by Watson and myself, and in Watson's case there is a distinct tendency toward a p-cliff in the vicinity of the Tower and in my case there is a notable expansion of space in the upper center of the map, around the dorms and along Oxford Street.

The intriguing aspect of the grid transformations is the amount of information they shed in both directions in the kid-city interface. In previous analyses we have seen, that although information was gleaned in respect to both environment and mapper, it was heavily slanted in either one direction or the other. This analysis goes both ways with amazing facility. This is clear in our conclusions regarding the first set of transformations. On the one hand we have set the stage for an examination of the development of projective systems on the part of the kids. On the other we have seen which aspects of the environment cause the greatest disturbance for the kids regardless of projection. Thirteen of the projections show deviance from the reference grid solely as a result of lack of clarity about the relationship between the Tower of London and a nexus of places in the vicinity of Whitehall. In twelve of the thirteen cases, this confusion has resulted in a p-cliff just to the east of Whitehall. The number of kids involved becomes even more impressive when it is noted that of the twenty-six maps displayed, ten of them didn't even show the Tower. Thus, twelve of the sixteen maps showing the Tower have moved it west, as well as south. How can this be explained?

One explanation has to do with the sightseeing tour that introduced the kids to the Tower. The morning portion of that tour was a connected exploration of London west of and including Whitehall. No incursion into the City was made at this time. Following lunch in the vicinity of the dorms, a long trip was taken (without commentary from the native guide) to the Tower, ending with the bus popping into a garage. Disembarking from the bus and leaving the garage the kids saw the Tower and the Thames. But, their previous experience of the Thames indicated that it was far to the south of the dorms, and the trip to the Tower provided no contradiction of this belief. As a result, the Tower was pushed farther south than would have been the case had the morning and afternoon segments of the trip been tied together. This, of course, has implications for the organization of sightseeing tours. They must be arranged such that it is possible to connect all portions of the tour into a whole. Our trip failed to do this. The return from the Tower took us rapidly past a variety of unimpressive landmarks, including pubs and office buildings on the Strand and Fleet Street. Then we arrived at Westminster Abbey. Sequential major landmarks were the Tower and the

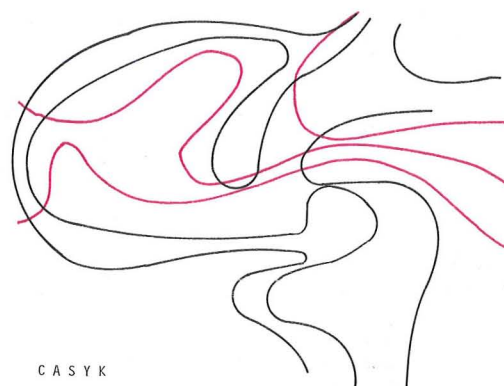
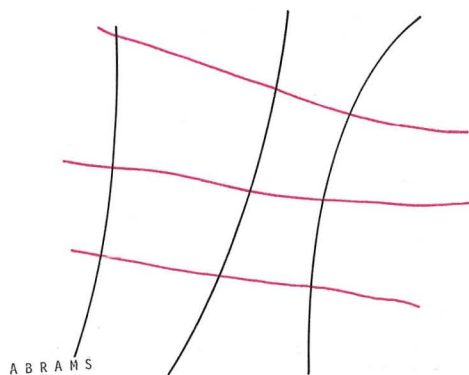
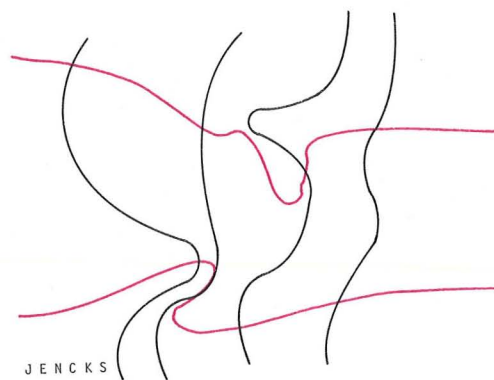
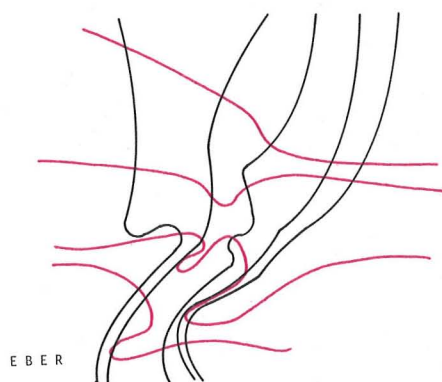
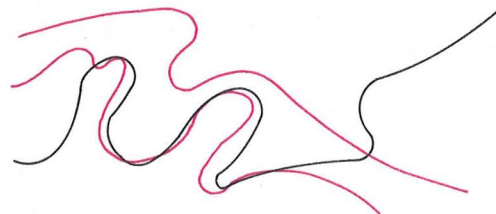
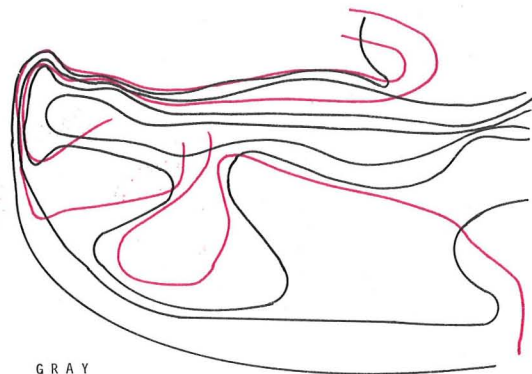
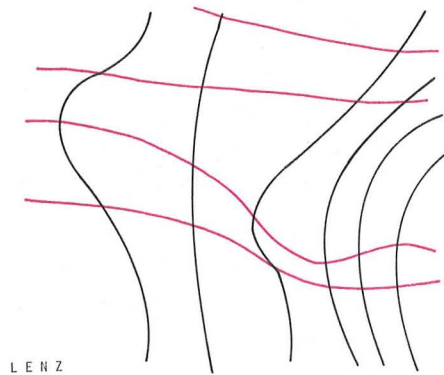
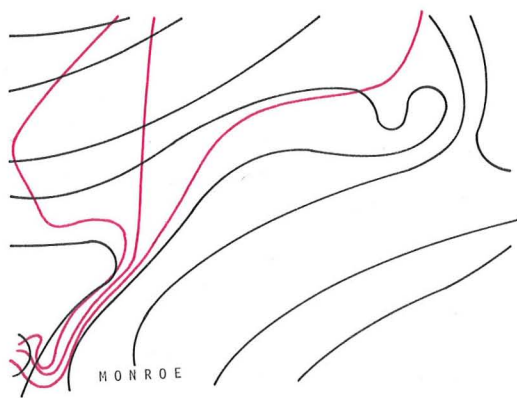


Figure 17.2A Transformations of the second London maps.

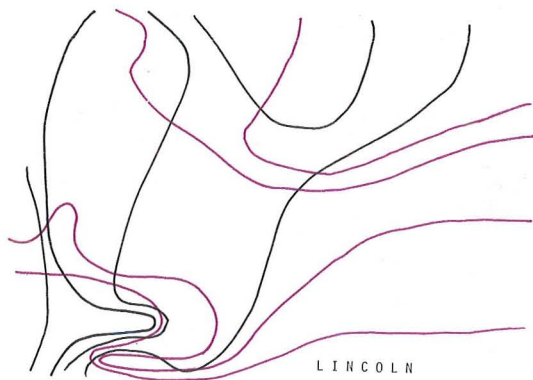
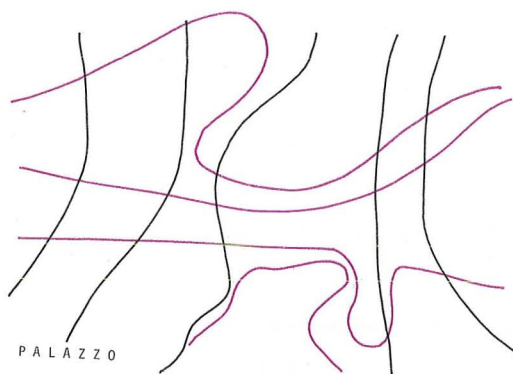
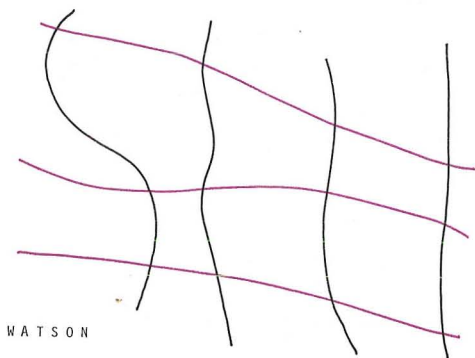
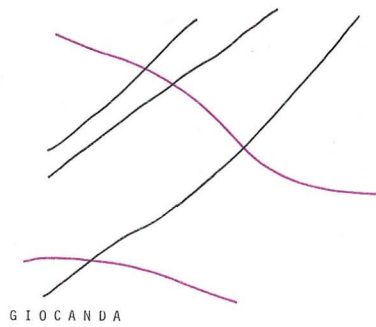
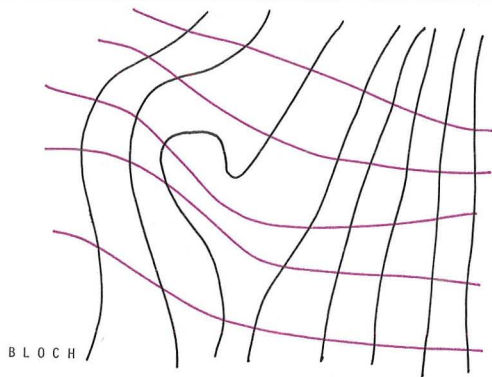
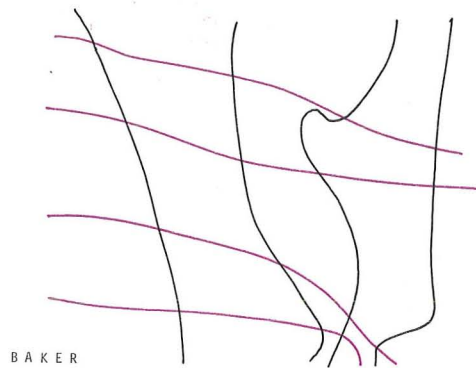
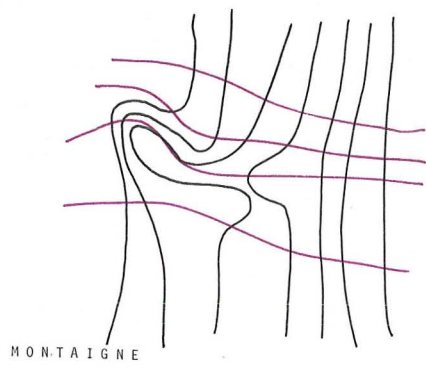


Figure 17.2B Transformations of the second London maps.

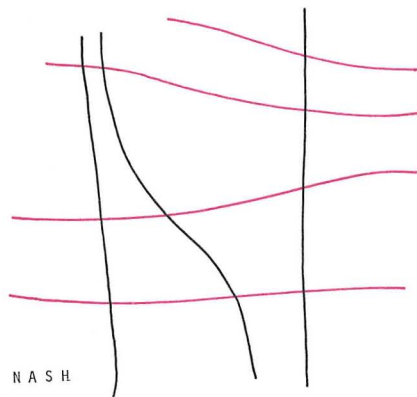
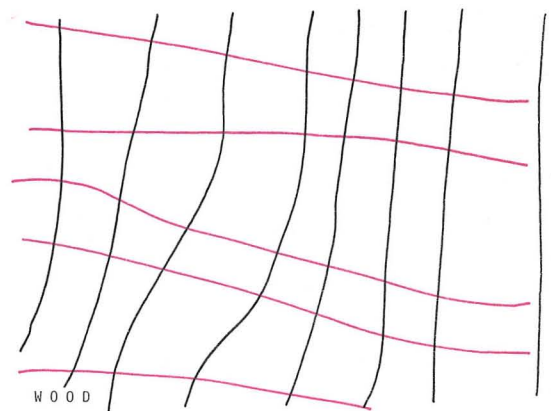
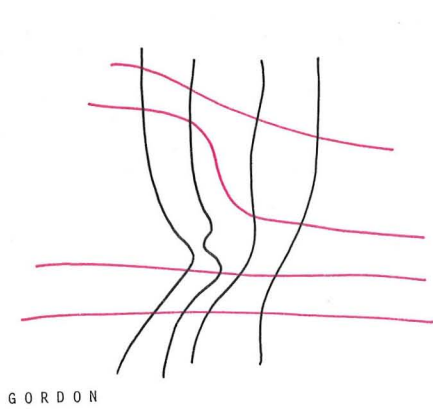


Figure 17.2C Transformations of the second London maps.

Abbey. But from the morning's tour we knew that the Abbey was adjacent to Parliament. Hence the three landmarks constituted a nexus of points together. Inevitably.

But what is the environment? It is not some God-given thing, but rather an event that is unfolded through time. Thus the environment of London as experienced contained the Tower next to the Abbey. In drawing the grid on the map we have re-introduced the non-sequential environment into the sketches via the reference map. Hence the grid transformation shows us trip sequence versus standard sequence, or trip time against what we might call reference time, or itinerary versus London.

Another explanation of the westward movement of the Tower has to do with London itself. The Tower is located at a great distance from the bulk of tourist London and is finally not conceptually connected into that London at all. The connections via the Strand and Fleet Street are clear enough to the vicinity of Mansion House, but beyond this lies a warren of streets confusing in the extreme. The only clear connection of the Tower to the balance of tourist London is along the Thames itself and this requires a launch excursion, usually terminating at Greenwich. As we shall see, the increasing frequency with which this launch trip is taken by Group L in their free time goes a long way to clearing up the confusion created by the sightseeing tour, for it established the shape of the river (recall the chaotic representations of this in the last analysis) and the unsuspected distance from Parliament to the Tower.

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The second set of grid transformations is shown as Figure 17.2 (A, B, and C). Our class of projections involving extensive curvature of space has shrunk, including now only Monroe, Hendricks, Casyk, Gray and Lincoln. Of these Monroe, Casyk and Lincoln exhibit the great Pagan curves while all of them show the more localized Lincoln variations. Note that Gray and Lincoln are still moving the Tower to the west.

Our second class, showing curvature, but such that it does not affect the entire map surface includes only Eber, Mayo and Palazzo. Mayo and Eber have moved the Tower west, but Palazzo has the river system cleared up. In support of our foregoing contention, both Greenwich and the London Observatory appear on the eastern extremity of the paper.

In the third category, grids with localized disturbances, we

find Gordon, Bloch, Jencks, Montaigne and Lenz. Bloch is still confused about the relation of Piccadilly Circus and Oxford Street, and that this confusion also shows up on the balance of the maps. This tendency, which begins to assume the proportions of the Tower issue, can be stated as follows: leaving the tube at Oxford Circus one proceeds down Regent Street to Piccadilly and then via Haymarket to Trafalgar. This trip is seen in one of two ways. Either it is seen as a trip due north and south with Oxford Circus in the north and Trafalgar in the south, or Regent Street is confused with Oxford Street and the sequence is seen as running east-west. Few kids understood the eastward displacement of Trafalgar even at the end of the trip, though the confusion between Regent and Oxford Streets was soon cleared up. In the pre-departure sessions, Bob insisted on drawing Trafalgar due south of Piccadilly three out of four times. It wasn't until he recalled the existence of Leicester Square that the fog cleared (and Bob's acquaintance with London has been extensive).

The members of the last category, containing right-angle grids, have increased in number, and more importantly, the areas covered by these grids have increased in size as is shown by the greater number of grid lines. Wood, Watson, Giaconda, Baker, Abrams and Nash fall here. Baker's two aberrations are extremely local, and the rest of the grids are quite right-angle. My own product is especially remarkable in that it covers all of London shown on the reference map and duplicates the reference grid satisfactorily. But I had been pouring over maps of London and thus had had considerable opportunity to reify my experiential knowledge.

With increasing regularity in the produced grids it becomes increasingly easy to pick out problems in the perception and cognition of London. There are now two of these that we can speak of with authority: the Tower-Parliament problem, and the Oxford-Piccadilly-Trafalgar problem. Furthermore, with two sets of maps to compare we can say something about the development of the mental surface of London. It is possible to consider the first set of maps as showing a landscape characterized by excessive geomorphic youth. This second set shows up a much older landscape, characterized by gentler slopes in the p-cliffs and a general movement towards a flat p-peneplain. This simply means that more kids are producing better approximations of the reference grid, and that fewer are deviating from it markedly.

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The third set does not show a continuation of these trends. These projections are displayed as Figure 17.3 (A, B, and C). The number of projections using extensively curved space has once again

increased. This class now includes: Cruz, Pagan, Lincoln, Giaconda, Casyk, Noyes and Jencks. The great Pagan curves are less in evidence than the more local Lincoln disturbances, which simply mean that London is increasingly grasped in its essentials, but that it is difficult to incorporate new experience easily into this framework. A variety of p-cliffs have arisen, but they result now, not from the Tower and the Piccadilly confusion (though there are remnants of these) but from St. Paul's and Madame Tussaud's. Thus Casyk, for instance, has moved the Tower east, and has begun to resolve the Piccadilly issue, but the major disturbance is caused by the location of St. Paul's west of the Whitehall nexus of points. But then, to a substantial extent, St. Paul's suffered from a similar history to that of the Tower: glanced at in passing in the afternoon portion of the sightseeing trip and located in the eastern confusion of London.

I have placed Eber alone in the second class, though her grid might well be included in the first class. Yet there is a tendency to a straight line right-angle grid that seems to separate her from the others. She makes clear the problems of the grid on this third map of London for all mappers. For instance, the mess she finds herself in in the north-west is due to her attempt to include Camden Town on her map, while excursions to the Soane Museum and the Elephant and Castle account for the balance of the aberrations. Thus, her deviance from a grid is without question a function of p-tectonic activity, or new experience. This general explanation is a covering rationale for the changes between sets two and three of London maps.

In our group of grids with only local disturbances we find five kids: Mayo, Watson, Bloch, Baker and Monroe. While each of these maps shows evidence of new experience, it is of a type more easily integrated into the map than was the case for the first two classes of mappers. Thus, Baker has added Kensington Gardens, but these are obvious extensions of Hyde Park; Bloch has added Marylebone Road, but this is basically an extension of Euston Road; Watson has added a great deal of detail in the Piccadilly area, but this was already located. The result of these additions has meant distortions, but they have remained local in impact. Thus the Marylebone Road has caused a curve in Bloch's second horizontal line, while the Piccadilly detail has meant a violation of scale in the center of Watson's map.

On the whole, this class of mapper has simply been more successful in incorporating added detail, either choosing the additions with care such that they would cause only minor variations, or starting off with stronger grids. But greater success doesn't mean that this class of mapper didn't have to face the same problem: the incorporation of new

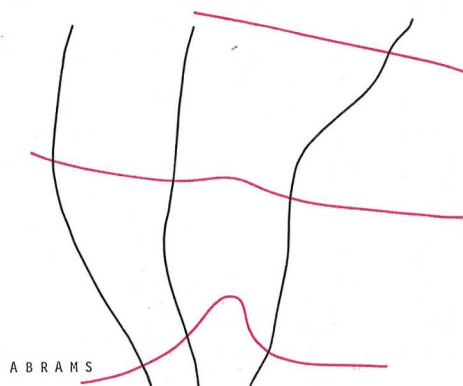
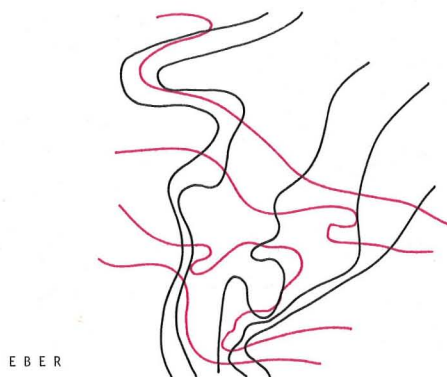
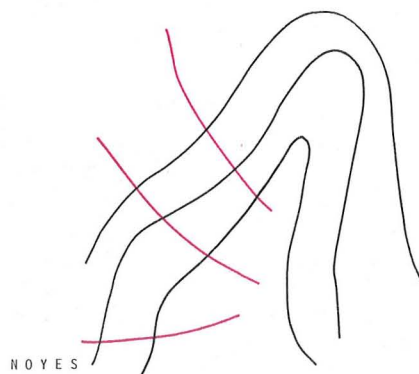
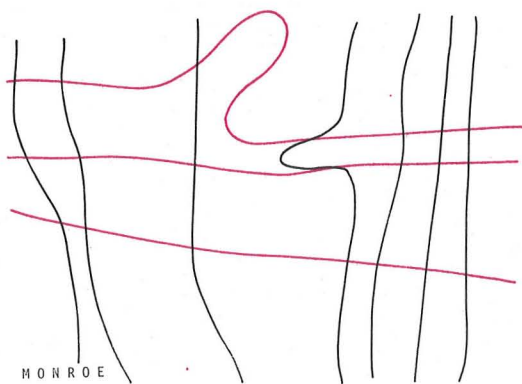


Figure 17.3A Transformations of the third London maps.

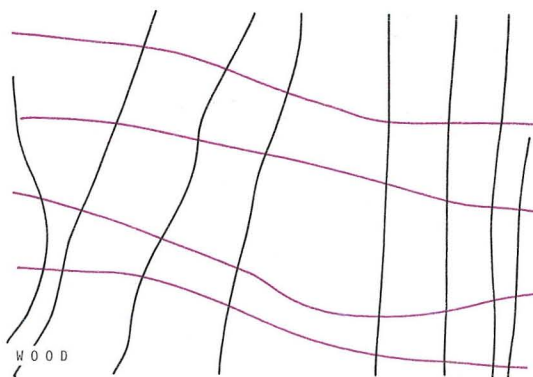
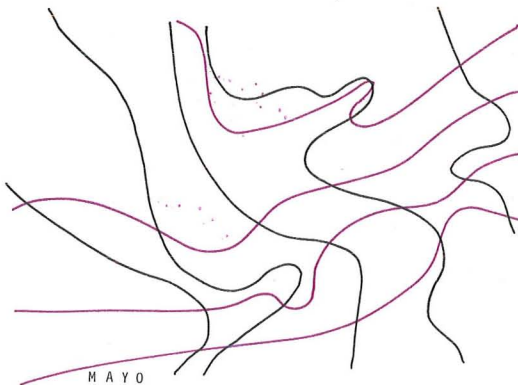
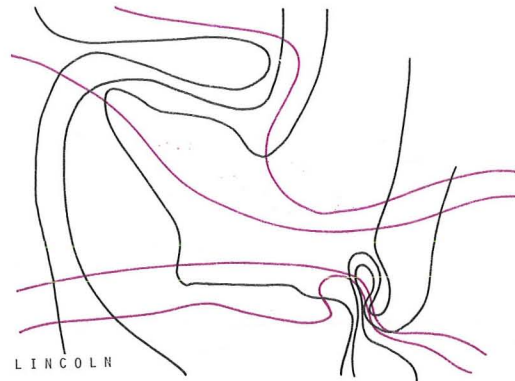
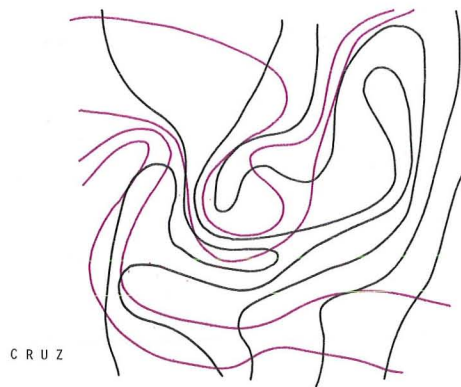
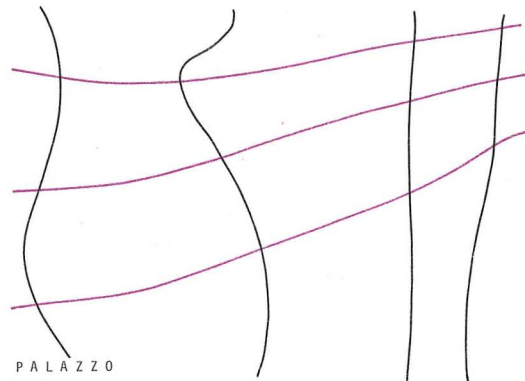
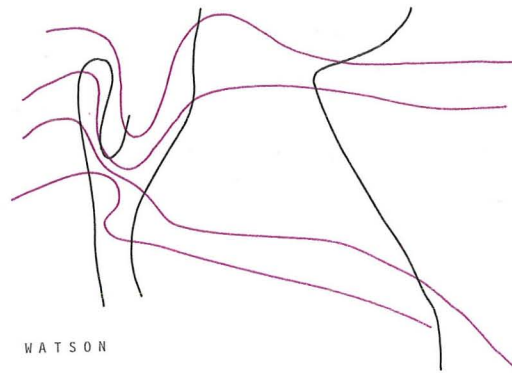


Figure 17.3B Transformations of the third London maps.

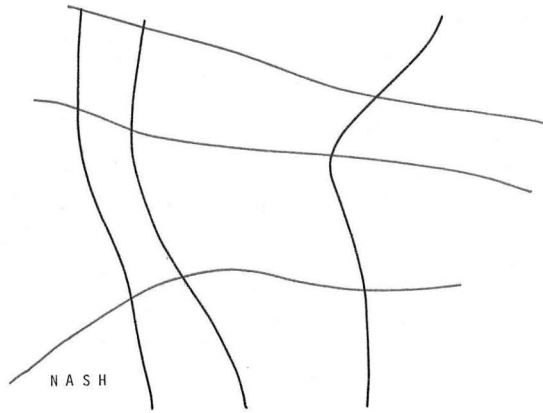


Figure 17.3C Transformations of the third London maps.

experience onto an old map surface.

Only four produced decent replicas of the reference grid: Wood, Abrams, Palazzo and Nash. This is Palazzo's first appearance in this class but the other three have been here with consistency. These three have added new material, especially Abrams, but they had strong grids to commence with. Palazzo's achievement results from a drastic slashing of places mapped. In her final map, she has shown only those places of whose location she was positive. My projection shows an incipient p-cliff developing as a result of explorations in the northwest not balanced by similar excursions in the southwest. In trying to get this all on the map, I have been forced to bend the north out and crush the south western corner.

In general, the third set of maps shows us a younger landscape than was apparent on the second set. This resulted from an apparent spurt in exploratory behavior, highlighted by the fact that few of the new places mapped appear on our List of London Places. What we have seen is a young surface in the first set, p-eroded leaving only resistant remnants on the second set, followed up p-uplift on the third set. We have concomitantly seen an emphasis on maps employing Pagan curves and Lincoln disturbances in the first set, have seen that this emphasis diminishes on the second set to be replaced by an emphasis on right-angle grids, and then watched the pendulum return. In other words: new experience leads to an inability to produce the reference grid, resulting in a young surface; time allows this experience to be organized, resulting in a trend toward an older surface and an increased ability to approximate the reference grid.

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The fourth set of maps is shown in Figure 17.4. All of them show no resemblance to the reference grid. All of them show the greatest amount of information shown for the mappers in question. All of them include abtruse places like St. John's Wood, Liverpool Station, Charring Cross, Queen Mary's Garden and White City. Each of these places, mapped for the first time on these fourth maps, caused excessive deviation from the reference grid. If it were permissible to generalize from such scanty data it would simply be to note that the upheaval seen on the third maps is continuing in this last set.

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The grid transformations are powerful images. It would seem that we have been able to trace the contours of a mental

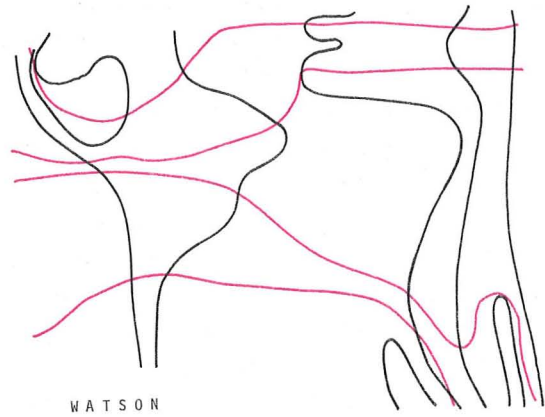
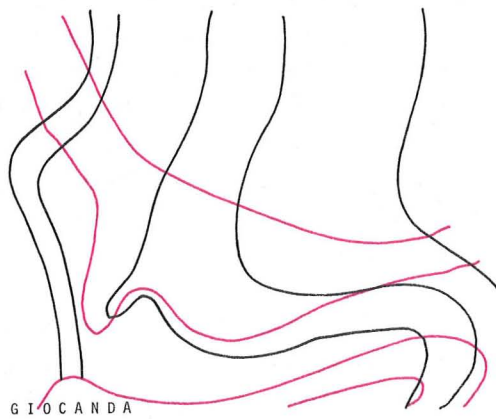
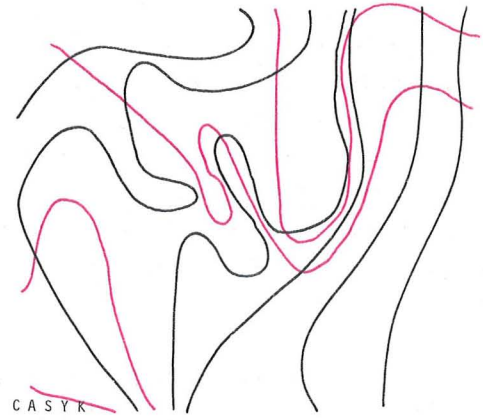
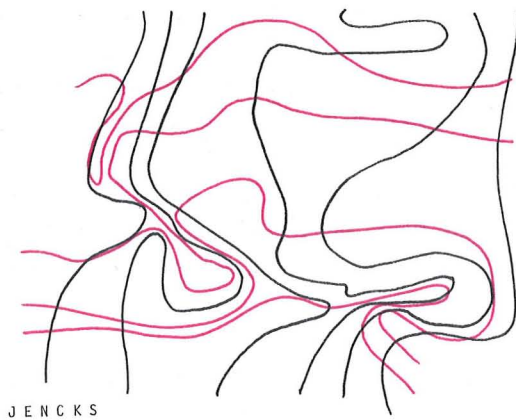


Figure 17.4 Transformations of the fourth London maps.

surface and present them as drawings. This is not true, but this is what the grids inevitably insist on suggesting. Perhaps it might not be unreasonable to let the suggestion transport us for a moment into such a consideration of the reproduced grids. For some reason I am compelled to stare at the grid inferred from Nybia Pagan's first London map. I look at those giant curves and find myself asking the same question over and over again: what is really going on with this map? What do these swirls mean? Was I really justified in drawing the grid on her map as I did?

The reasonable answer is "Yes." I have made the reasonable argument already. Nybia didn't get lost. Nybia did walk down Tottenham Court Road and finally reached the Thames. Obviously in her mind she was capable of making these connections between streets and points and finding her way about in a big city. And the map that she drew for us is an attempt to place on paper these same connections. Thus the map that she drew represents these same connections. Faced with her map I made four or five grids that satisfied the basic rule of navigational sufficiency, and yet something was wrong. The resultant grids were screwy, cock-eyed, messy, insane. After drawing each grid I would ponder it, trying to figure out what had been transpiring in Nybia's mind. And then I drew the grid that I have reproduced. What finally satisfied me about this product was its simplicity, its elegance, its ability to unify seemingly contradictory sets of spatial relationships. And while the grid made sense of the map, it left unanswered the real question: why had she drawn it as she did? This is the question implied by: what do the grid transformations really mean?

Let's try to imagine a set of circumstances that would answer that question. Here is Nybia proceeding down a street. She thinks she's walking north. After a while she reaches a point that she knows is south. How can she possibly reconcile these two facts? She could assume that she had walked in circles. But then why wouldn't she draw this on her map? She could assume that she was wrong about the direction in which she'd started walking or the orientation of her end point. But she shows these contradictorily oriented on her map. What is she to do? Well, she might never attach the two pieces of information together in the first place. That is, she might never add the two hunks of experience up. In which case the contradiction would never appear to her. Or she might assume that she failed to understand the nature of the links between the two experiences and in her drawing concentrate on the two experiences about which she felt some confidence, and let the connections go hang. Or she might suffer from some sort of spatial schizophrenia of a hitherto unidentified type. Or anything else. The possible explanations get very spaced out. I like the first explanation anyhow, that she never added up

the hunks of her experience. It would imply that experience is discontinuous in nature, and there is nothing to suggest that it isn't. And it wouldn't surprise many of us, who have all undergone similar shocks in moving through the environment. How did this street end up here? I thought I'd already passed that building? And so on. How many of us follow up these environmental clues, search out their reasons, learn to see what's going on? Very few. We are in a hurry to get somewhere, and just press on.

Go back and flip through the grids with these thoughts in mind. In some very real sense, thought not that naively perceived, the grid transformations do allow us to look into someone's mind, maybe only for a second, when that person crosses a shocking street and dismisses it from mind, but a glance nonetheless for that. They allow us this glance by organizing the superficial order of the sketch map into a couple of simple sets of lines. There is no saying "But this should be over there and this is too far west," for each map, but the contemplation of a grid that does it all for you.

III

For Rome we present sixteen transformations from each map session. These were chosen at random from the complete set of transformations, simply because it costs too much money to reproduce the whole set for you. And the selection will not seriously hamper our conclusions. The transformations from the first Rome maps are shown as Figure 17.5 (A and B). In the first class of transformations I put those of Eber, Giaconda, Portman, Jane Brown and Phylis Gordon. Three of these maps are characterized by massive but gentle Pagan curves: Gordon, Brown and Portman. That is to say that they consist of grids but grids located in radically curved space. These curves do not result from the mislocation of a couple of points as we know, but from some more fundamental confusion. Eber, who has been drifting toward this class gradually from her London first map, goes all out here producing one of the most systematically confusing grids it was my pleasure to construct. In addition to exhibiting Pagan curves, Eber shows us a not before seen type of involuted space reminiscent of a Klein bottle. Where are the edges of Eber's Rome? It's an intriguing and unanswerable question.

Once we step out of this class, all the grids are surprisingly close to the reference grid. In the next class I have included the transformations of Fisher, Lincoln, Montaigne and Bill Brown. Note that they show excessive curvature of the map surface, but that this curvature is localized.

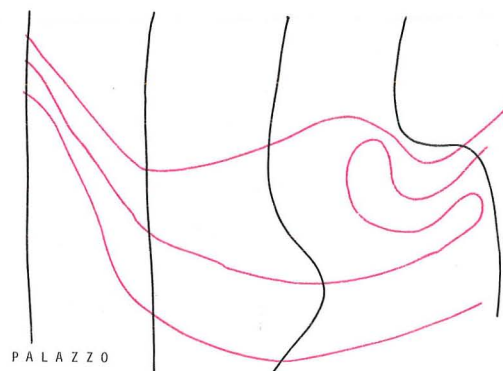
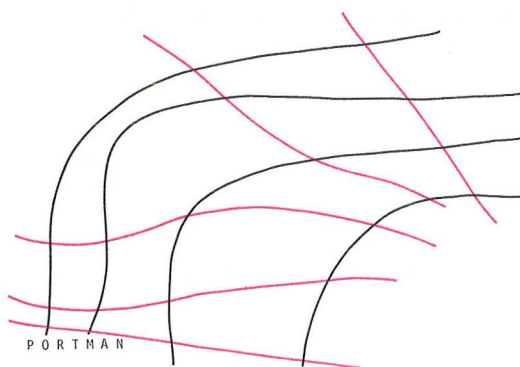
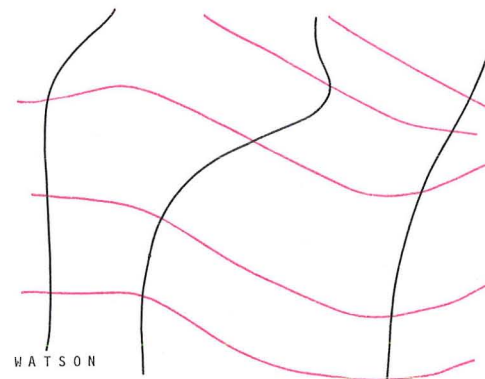
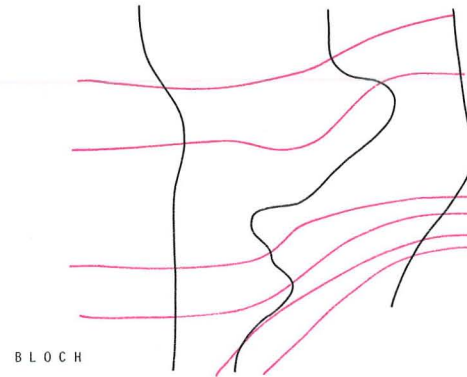
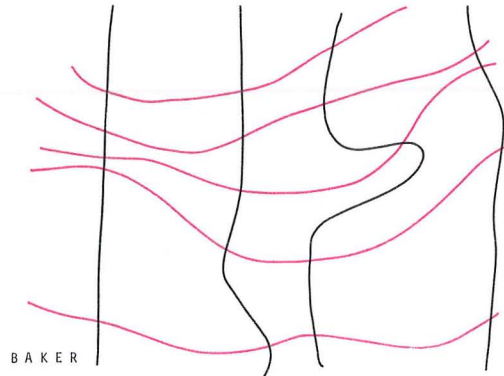
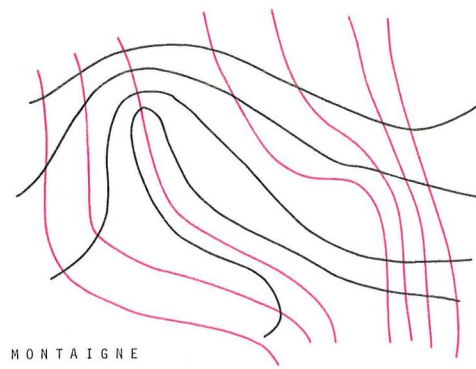
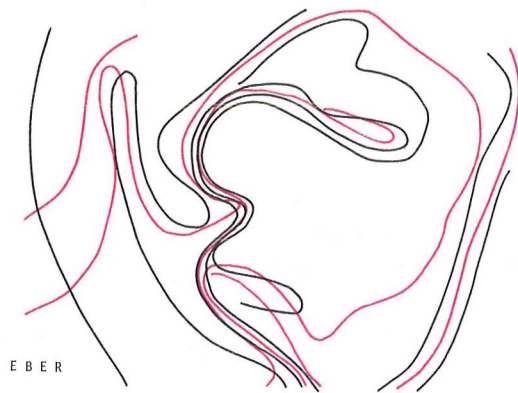
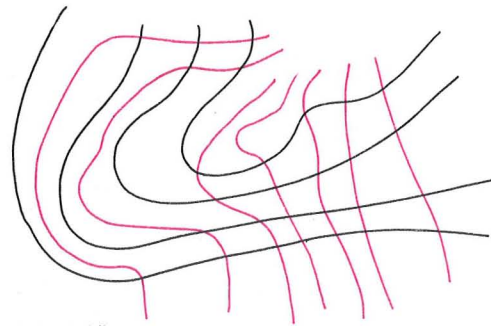


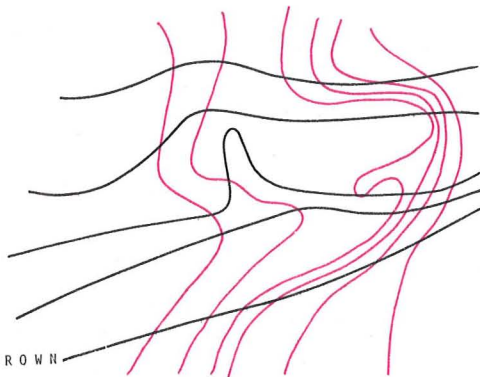
Figure 17.5A Transformations of the first Rome maps.



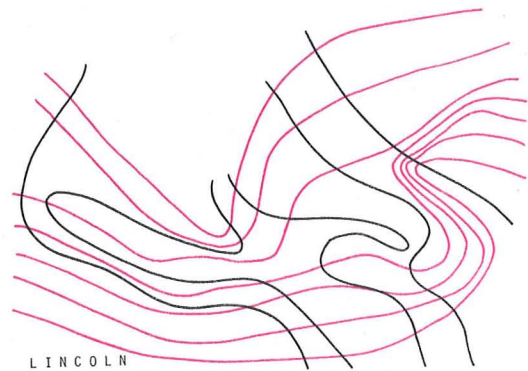
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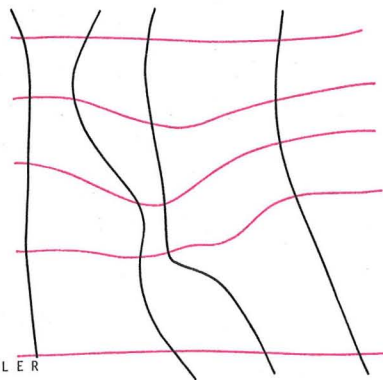
J. BROWN



B. BROWN



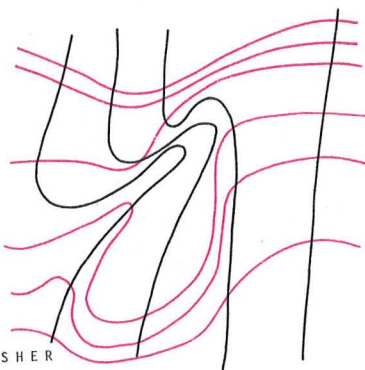
LINCOLN



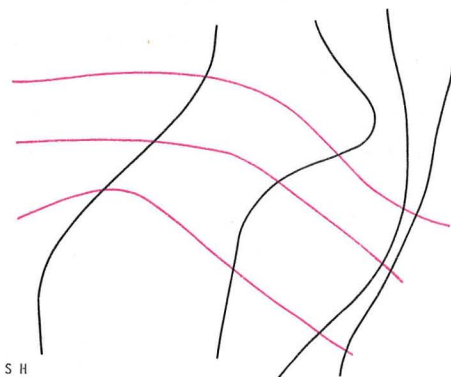
HELLER



GORDON



FISHER



NASH

Figure 17.5B Transformations of the first Rome maps.

In the third class, that of grids with only minor aberrations, I have included the grids of Baker, Bloch, Watson, Palazzo and Pierce. Notice the gentle p-cliffs developing in the left center of the grid on some of these, or in the lower right hand corner. Some of these gentle p-cliffs also appeared in the previous class.

Only Heller and Nash have been included in the right-angle class, and Nash's inclusion here and not earlier is a matter of debate. Heller without question drew the most magnificent Rome map in the set in hand. It was literally crammed with information, highly connected, and, as you can see, produced a remarkable approximation of the reference grid. Nash achieved his comparative success by dealing with only a few places. The remarks penciled on his map were illuminating, both in regard to our London discussion and regard to the following Rome discussion. He says: "I can't recall our route from the afternoon at all!!!" He refers to the sightseeing tour of Rome which had taken place on the day, but before, these maps were drawn. The Rome tour was a duplicate of the London fiasco. There was no connection between the morning leg and the afternoon leg, and as a consequence most of the things seen in the afternoon were not found to be capable of organization into the Rome map developed by the kids in the morning. Even aided with a map, it was only with great difficulty that I was able to follow the route taken in the afternoon to the catacombs. Heading to the other side of Rome, we went around Rome. Now this is marvelous from the point of view of saving time, but disastrous from the point of view of building up a coherent connected image of a city. As a result of this the catacombs, the Via Appia Antica, the Baths of Caracalla, and the Circus Maximus (refer to map of Rome, Chapter 10) were sources of great confusion on this set of maps, and since there was no opportunity, nor reason, to revisit the vicinity of the catacombs, these provided a great source of confusion throughout the Rome maps. Many kids mistook the location of the catacombs for the northeast and thus rotated their maps 90°. Further confusion was caused by the purchase of maps of Rome with south at the top. Mislocation of the afternoon portion of the trip vis-a-vis the morning caused all the Pagan curves in class 1, most of the aberration in class 2, and accounts for the gentle p-cliffs in class 3. That Nash avoided these problems he has explained. He didn't even bother to integrate the morning and afternoon experiences but stored them separately (shades of our explanation of Pagan's behavior in London—it could be the right one). Heller avoided the catacombs but included the trip into Rome taken on the previous day which he was able to integrate, miraculously, for the location of the Olympic Stadium also proved to be a bit much for many of the kids.

Over all, though, given the first London maps, these grids

present us with a surprisingly old smooth first surface.

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This smooth surface continues to predominate in the second set of maps (Figure 17.6). In the chaotic category we place only Lincoln, Pagan, Casyk, Cruz and Jencks. All of them have been here before and four of them have been here with great consistency. Gradually, as we progress through the data, personality associations with the mapping process are beginning to show up in this analysis as in the past. Jencks at least has the west bank of the Tiber figured out including the location of the Olympic Stadium, but is thoroughly confused as to the interior arrangements of downtown Rome. Wreaking great havoc is his idea of the location of the Baths of Caracalla and the Circus Maximus. Pagan is busy proving why we call them Pagan curves. She has placed everything in Rome north of the Tiber and exhibits all the symptoms of this class of grid: Pagan curves, Lincoln disturbances and now, Eber involutions. Cruz's big problems are the relative location of the Stadium and the catacombs vis-a-vis the rest of the city. Lincoln makes a similar confusion, as does Casyk. Casyk wrote on her map: "I didn't want to do this map because I didn't know anything new." This was a common complaint about the second Rome maps: no new experience has transpired geographically. It just didn't make sense, under that constraint, to draw another map. Of course, this applied only to those kids who had used their free time to soak up a sun-tan at the dorms rather than explore the city.

In the second class I have included those grids that, relative to the first class, were leaving the fog. Here we find Eber, Palazzo, Noyes, and Bill Brown. Given Eber's remarkable first Rome grid, she has definitely moved into the second class. She exhibits tendencies toward Pagan curves, but has divested herself of involutions. Most of the confusion can still be attributed to the sightseeing tour. The same applied to Palazzo's tendency to Pagan curves.

In the third class I have included Gordon, Bloch, Giaconda and Montaigne. These products are definitely right-angle grid-like and show only local variation. Compare this grid of Montaigne's with the grid she produced on the London maps. There are enormous similarities. She wrote: "I did not go out today! I forgot a lot." Giaconda wrote: "Did not go to the city." Gordon wrote: "Didn't go anywhere." Nonetheless, either they have studied maps (unlikely), or the passing of time without new experience has allowed them to organize their image of the city, for both Giaconda and Gordon have moved from the class of chaos to the class of mere local variations.

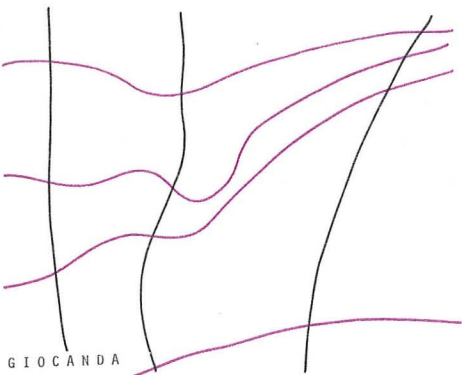
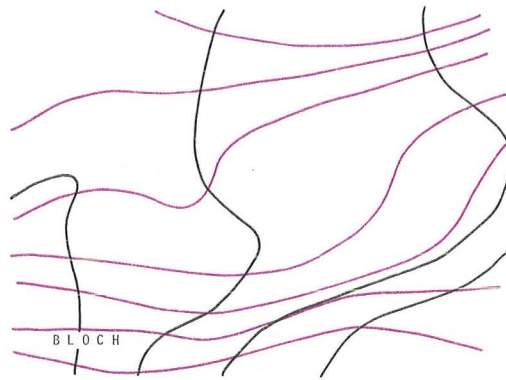
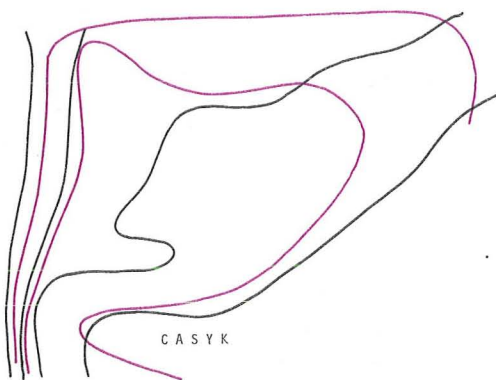
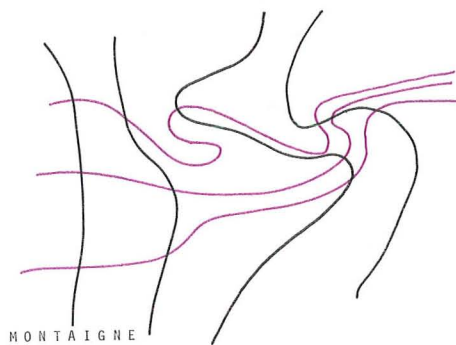
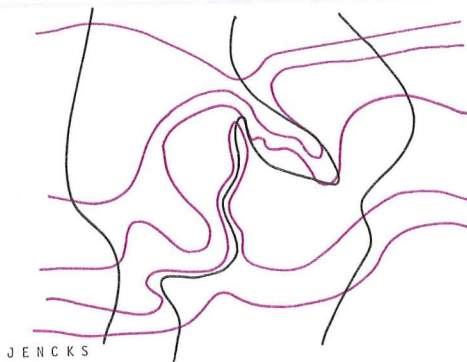
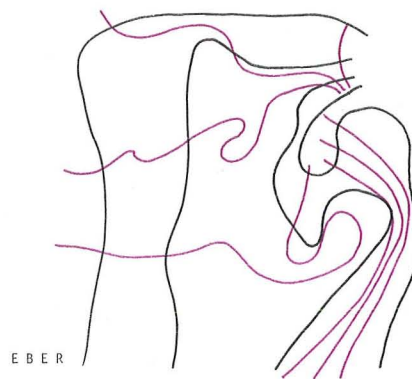
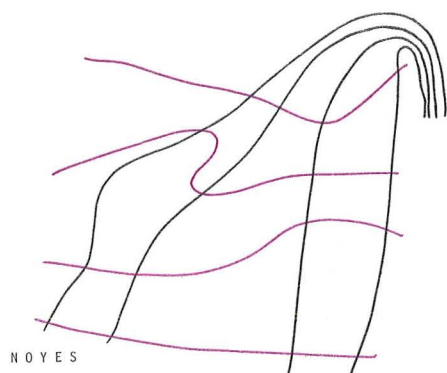


Figure 17.6A Transformations of the second Rome maps.

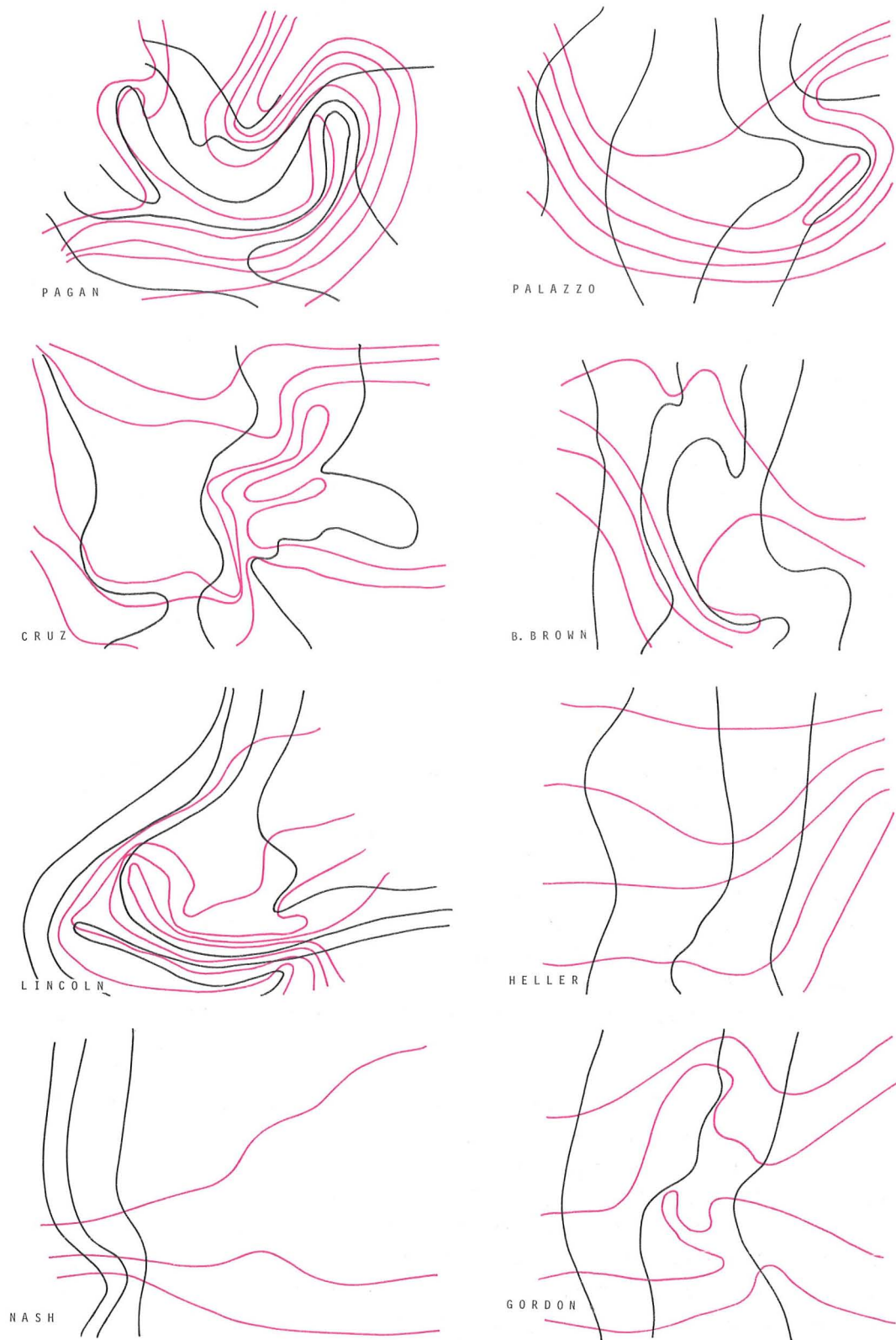


Figure 17.6B Transformations of the second Rome maps.

In the fourth class we have only three maps: those of Heller, Watson and Nash. Watson's is the closest to a real grid. Heller has gone afield into parts of Rome where he is less at ease, and Nash has shown the search for the guitar shop (where he bought his guitar) and correspondingly bown up the space of downtown Rome to accommodate the detail.

The general feeling as we move from the first set of maps to the second is one of stasis. There has not been a significant leveling of the already relatively smooth image of Rome, nor has there been a great upheaval of the surface. There seems to have been relatively little new experience of Rome between the two sets and the lapse of time has either led to increasing chaos (in the case of the first class) or increasing grid-likeness (in the case of the third class). It would seem from these data that the effect of time has been to cause forgetfulness or reification. Recall that the depiction of the river (in the last chapter) from set one to set two had increased markedly in consensuality, and that content has been added to the second set both of lines and areas. Though this is true, it seems to have had little general effect on the state of the shape of Roman space.

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The third set of Roman maps—Figure 17.7 (A and B)—tells a wholly different story. There has been an invasion of the first class and total abandonment of the fourth class. It would seem that the kids finally left the dorms, and we know that the morning they drew these maps had included a compulsory visit to the Sistine Chapel. That they went on this trip in large numbers is confirmed by the content analysis that shows the discrimination of the Vatican area into four points on the third maps: the Sistine Chapel, the Bernini Colonnade, the Piazza San Pietro and St. Peter's itself. So, with new experience of Rome itself, we might expect a great deal of crustal activity.

The first class is well represented: Eber, Lincoln, Pagan, Cruz, the two Browns, Seward and Casyk. Most of these are old hands at dealing with this class of projection. Most of them show the full range of class one deformities, including Eberian involution, except, stunningly, Eber herself. Her map is a new type entirely, showing Pagan curves with an incredible variation in grid square size. A great deal of this can be attributed to old problems: the Stadium and the Catacombs, but there are new players as well, namely the Piper Club Discoteque and the Stazione Termini. These two items had a tendency to float north, relative to the Piazza del Popolo, and generally squash the northeast corner of Rome while expanding the western portions, especially when

conjoined with the evil influence of the Hilton Hotel and the Stadium. It may seem remarkable that the mort main of the sightseeing trip could reach so far, from day one in Rome to day six, but actually anything else would be a surprise. For unlike London, there was no real reason to visit either of these places later and gain a new understanding of their relative locations. Having mapped them once, they were fixed in the mind, and there was nothing to encourage taking a consulting opinion. These locations were reaffirmed on the second map and still nothing—no new experience of these places—intervened. And so they continue to appear mixed up on the third map. It is important—vital, beyond statingly important—to understand the effect of a mistake in geographical comprehension once made and uncorrected. It is devastating to any attempt to construct a complete image consensual to anyone else's. These kids never had any doubt that they knew where the Olympic Stadium and the Catacombs were. Too bad they were off 90° to 180°. Designers of tours with the slightest bit of compassion for the geographical knowledge of the tourists must take into account the necessity of designing these tours in such a way that it is possible to connect the entire day's outing. We saw the effect of a discontinuous tour in London, and we saw what was needed to correct the misapprehension; and now we see in Rome that there are likely circumstances under which the misapprehension will never be changed at all.

In the second class I have included only Miss Bloch. She shows us a fairly rectangular grid, but there is a serious p-cliff—heading into the Catacombs—and some confusion about the bearing and location of the Via del Corso, which she amazingly seems to have confused with the Via Aurelia.

Included in the third class, that of grids with only local disturbances I have included the balance of the projections: Nash, Abrams, Palazzo, Gordon, Watson, Giaconda, and Montaigne. Included in this class are all those kids who normally would have given us right-angle grids, but the local confusions are too marked in this third Rome set to allow that. The confusions are isolated and minor: Piazza Nuvona due south of the Pantheon for instance, or the Spanish Steps as far north as the Piazza del Popolo, or a drastic separation between the Roman Forum and the Coliseum. Montaigne seems to have a fixation on producing a map of one type. Compare all her past grids. They are practically identical, London to Rome and within each city. The Baths of Caracalla (also the Circus Maximus) is the one confusion resulting from the sightseeing tour that was ultimately straightened out and this because the opera, Aida, which most of the kids attended, was held here. In this instance they did have a repeat visit that allowed them to resee the connections.

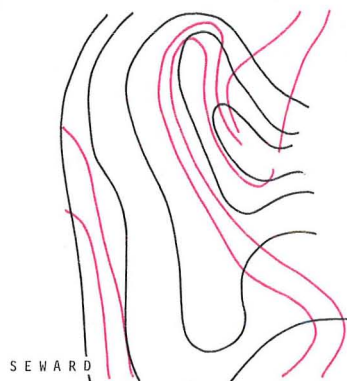
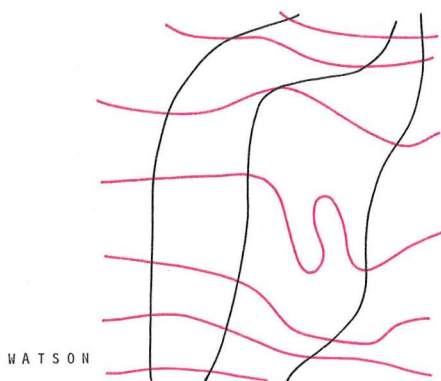
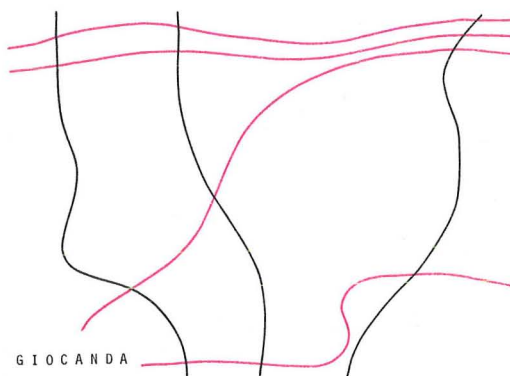
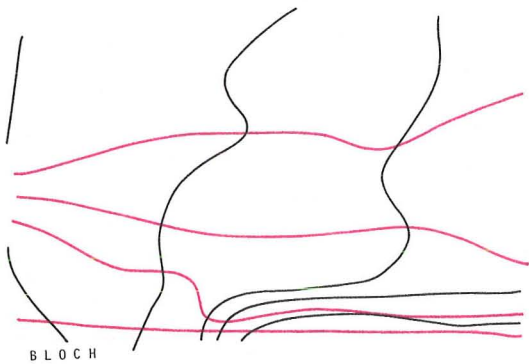
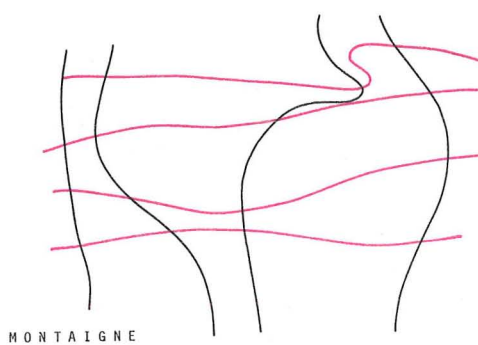
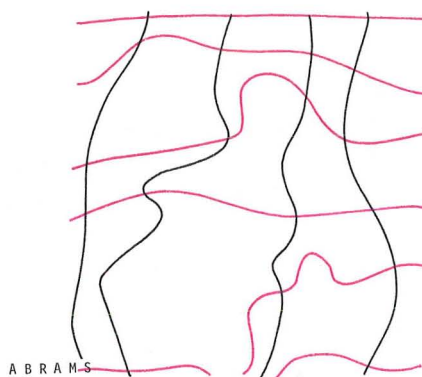
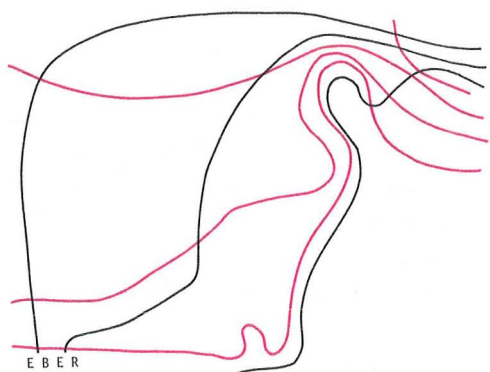


Figure 17.7A Transformations of the third Rome maps.

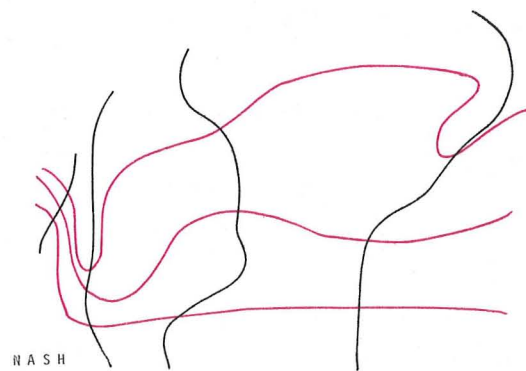
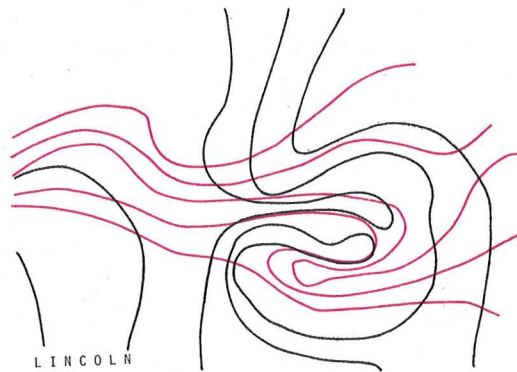
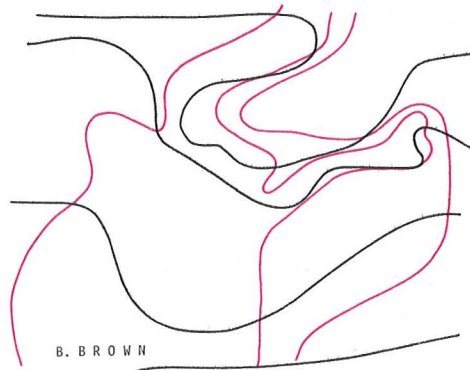
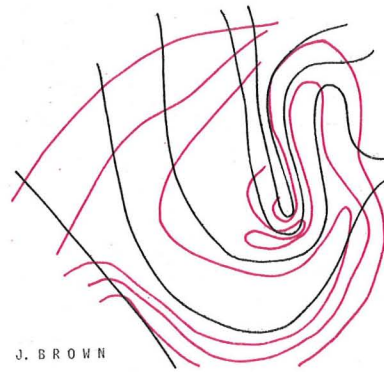
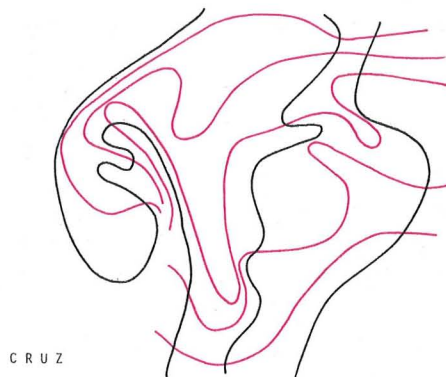
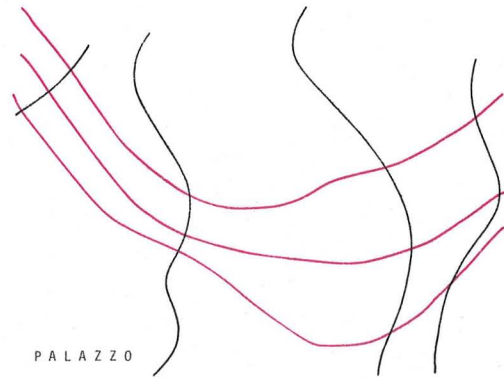
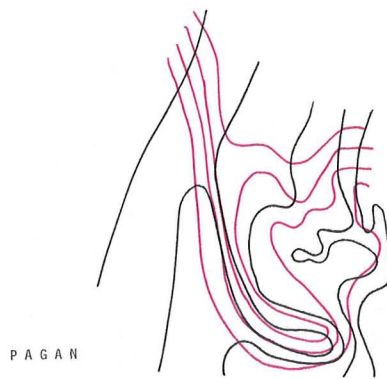


Figure 17.7B Transformations of the third Rome maps.

In general terms this last set shows the result of new experience, resulting in an inability to accurately approximate the reference grid and in a surface characterized by upheaval. Of all the maps seen so far, the third set in Rome gives evidence of the very greatest confusion. You will note that this is true in spite of the results of the content analysis (increasing consensuality, increasing numbers of points and lines and areas from one set to another), and in spite of the increasing agreement about the shape, length, bearing, location and mode of representation of the Tiber. If you are interested in the more complex issue of the relation of these points and lines to each other though time and vis-a-vis a particular standard of reference, content analysis will tell you nothing; nor will graph or pseudograph analysis; nor will the analysis of selected items in isolation. The analysis of sketch maps using the method of grid transformation will get you into the heart of the map. As Bunge would say, it's a bleak prospect once you get there, but there it is. Without discussing the personality issues at stake in this analysis, all we have been able to accomplish so far is:

- 1) The isolation of certain confusing features in the landscape which may be confusing because:
 - a) They are confusing in and of themselves, or
 - b) Because they were presented in a confusing manner.
- 2) The awareness of an incredible range of possible grid transformations all falling within Tobler's most inclusive class.
- 3) The division of this range into highly subjective categories of approximation of the grid of Tobler's least general class.
- 4) A description in geomorphic terms of the changes of the surface from one set to another, through time.

IV

But it never does to despair. The Paris data is sufficiently different to keep the momentum of discovery going. There are sixteen grid transformations for the first set of Paris maps and they are shown in Figure 17.8 (A and B). I only placed five kids in the first class of highly variant projections: Nash, Lincoln, Cruz, Palazzo and Noyes.

Nash may or may not belong here. The grid shown for him would certainly seem to place him squarely in this class, but that depends entirely on whether or not one considers his map one or two maps. I did not feel that I could with clear conscience consider it two maps, although the two distinct constellations that appear on the sheet show no indication of any connection whatsoever, and represent entirely disjunct parts of the city. These two parts are, as you see, oriented in opposing directions and this within the context of a compass rose drawn on the map sheet. The balance of the confusions in this class in this set result from a lack of clarity about the side of the river the kids were on when they saw many things. So it is that the Opera appears on the Left Bank while the Ecole Militaire appears on the Right Bank (see map of Paris Chapter 11). At least nobody confused the Right Bank with the Left, which rather surprised me as I had supposed they would.

In the second class I have included the grids created by Casyk and Gordon. Gordon clearly belongs here as she has managed to produce a grid, while not right-angle, at least then recognizable as a grid. The deformation is a tribute to her placing the Eiffel Tower and the Ecole Militaire on the Right Bank. Leslie Casyk's problem involves the Opera on the Left Bank and the location of the Louvre halfway to Le Havre. And yet even so it is a grid visible to the naked eye.

The class containing only local, minor deviations from the straight and narrow is rather large: Needham (she drew a complete set of Paris maps), Baker, Giaconda, Pagan and Heller. The only real puzzler in this class is Pagan and yet there can be no doubt that she belongs here. A couple of the maps show the Eiffel Tower on the wrong side of the Seine but within a surrounding matrix that prevented the disaster that this could have meant.

In the class of class grids (right-angle) we find Abrams, Monroe, Eber and Prinz. These aren't perfect grids, but Monroe and Abrams come awfully close. It isn't the first set of grids for Paris that is so surprising. Let's move right on to the second set, without puzzling about the Eiffel Tower on the wrong bank.

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Of course we show only eight grid transformations, as Figure 17.9, but nonetheless they include a full range of mappers. Behold: there are no mappers at all in the first class. Indeed the maps of the second class, where I put Heller, Gordon, Palazzo and Pagan, are remarkably right-angle straight-line grids. Perhaps Heller's belongs here ordinarily, but in Rome or London I might well have placed the other

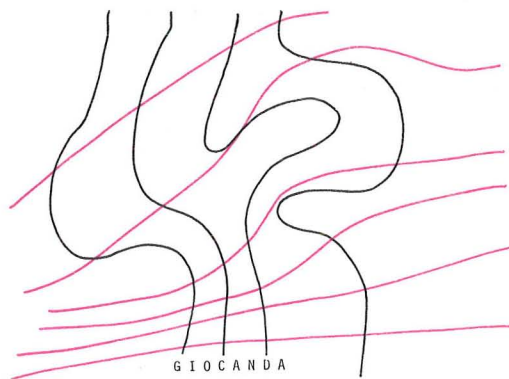
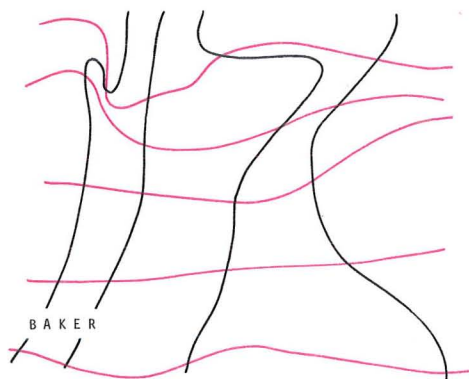
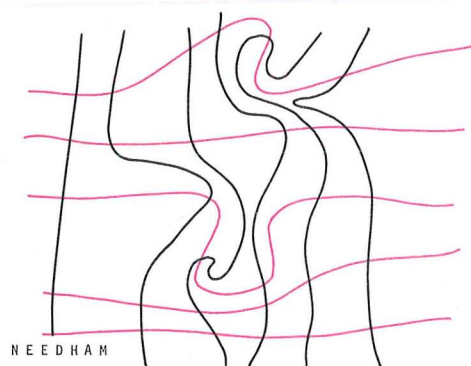
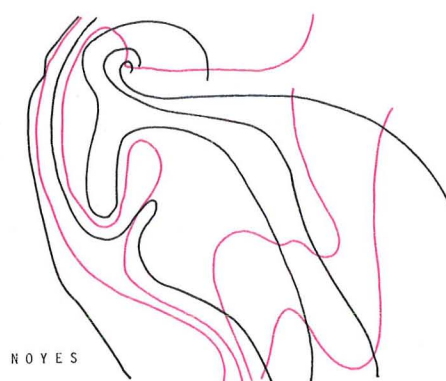


Figure 17.8A Transformations of the first Paris maps.

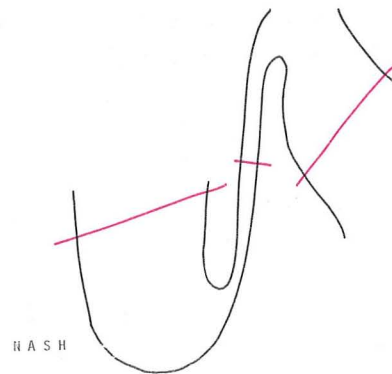
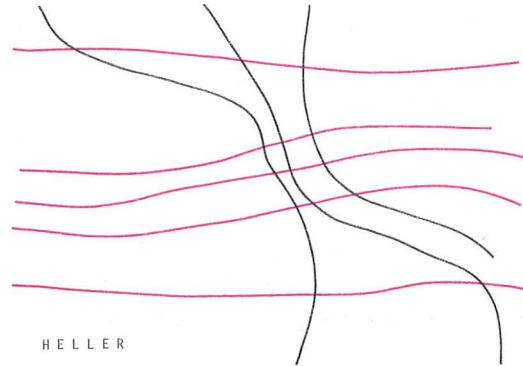
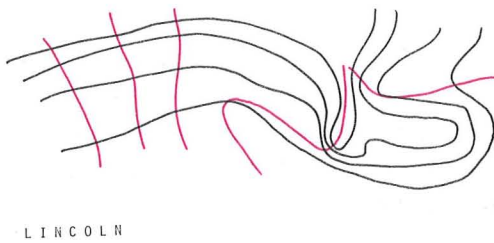
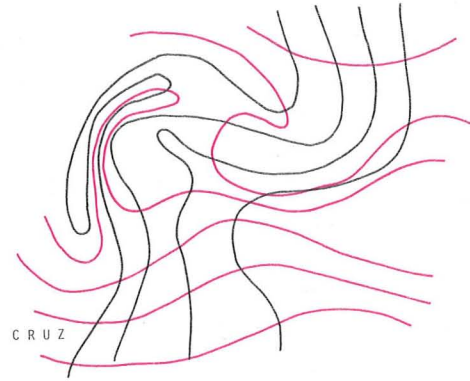
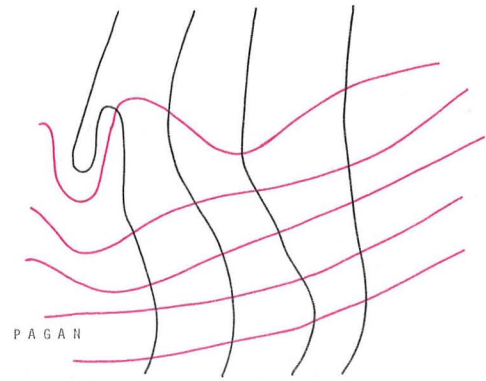
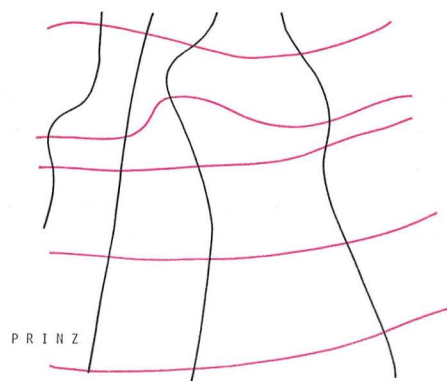


Figure 17.8B Transformations of the first Paris maps.

three maps in the third class. The minor nudge of the grid on Gordon's map comes from having pushed the Porte St. Denis to the west of the Sacre Coeur and having dropped the Sacre Coeur as far south as the Porte St. Denis. In other words, her problem is abstruse and negligible. Eber has seen fit to diminish the august grandeur of the Louvre producing a restriction in the middle of her grid. Palazzo has drawn us almost a perfect grid.

But look at the rest of the grids: Giaconda, Abrams and Monroe. How can you distinguish as we have been, when all the transformations show straight-line right-angle grids? Abrams' transformation is not so special in Paris, where Giaconda and Monroe can come up with better. What kind of a mental map surface are we seeing here in Paris? It is a peneplain on the second set, an old well-known flat without so much as a resistant outcrop. This difference cannot be explained by the small sample for contained in that sample are mappers who have lodged themselves in previous cities in all classes of grid transformation with regularity. No, there is something about Paris, something we noticed in the content analysis with the florescence of lines on the first map set, something we noticed in the river analysis with impressive consensuality on the first set and total consensuality on the third set. Either Paris is the most legible city we encountered in Europe, or the kids have developed a strategy for dealing with novel environments that is paying off at last. Unfortunately, we have no hint anywhere of the nature of this unknown strategy and must fall back on what is left; and what is left is Paris, gorgeous, marvelous and as legible as the stained-glass windows of the Saint Chapelle. What else can explain this ability to produce grids that are grids the second time out when in every other city such production has never taken place (to the exclusion of the first class of maps)? Nothing that I can think of.

I would be a sorry sucker if after saying all that the third map set wandered off to Xanadu, but behold Figure 17.10. They hold the line. Need I say anything. Casyk is performing as usual and I have placed her in class 2 for show, but she has still managed to put the Eiffel Tower on one side of the Seine and the École Militaire on the other; and Luxembourg is skewed awfully to the west. But the underlying right-angle grid shines through. The amazing thing about David Abrams is his unswerving consistency. His transformation in another city might well have found him alone in class four, with the only approximation of a right-angle grid. But in Paris he is a mere class three mapper. He hasn't changed, but the rest of the kids have. Phylis Gordon joins him in this class, locating the Jardins de Luxembourg south of the Pantheon and the Trocadero too far east. But she has cleared up that problem relating to St. Denis and the Sacre Coeur. Five of our kids are in class

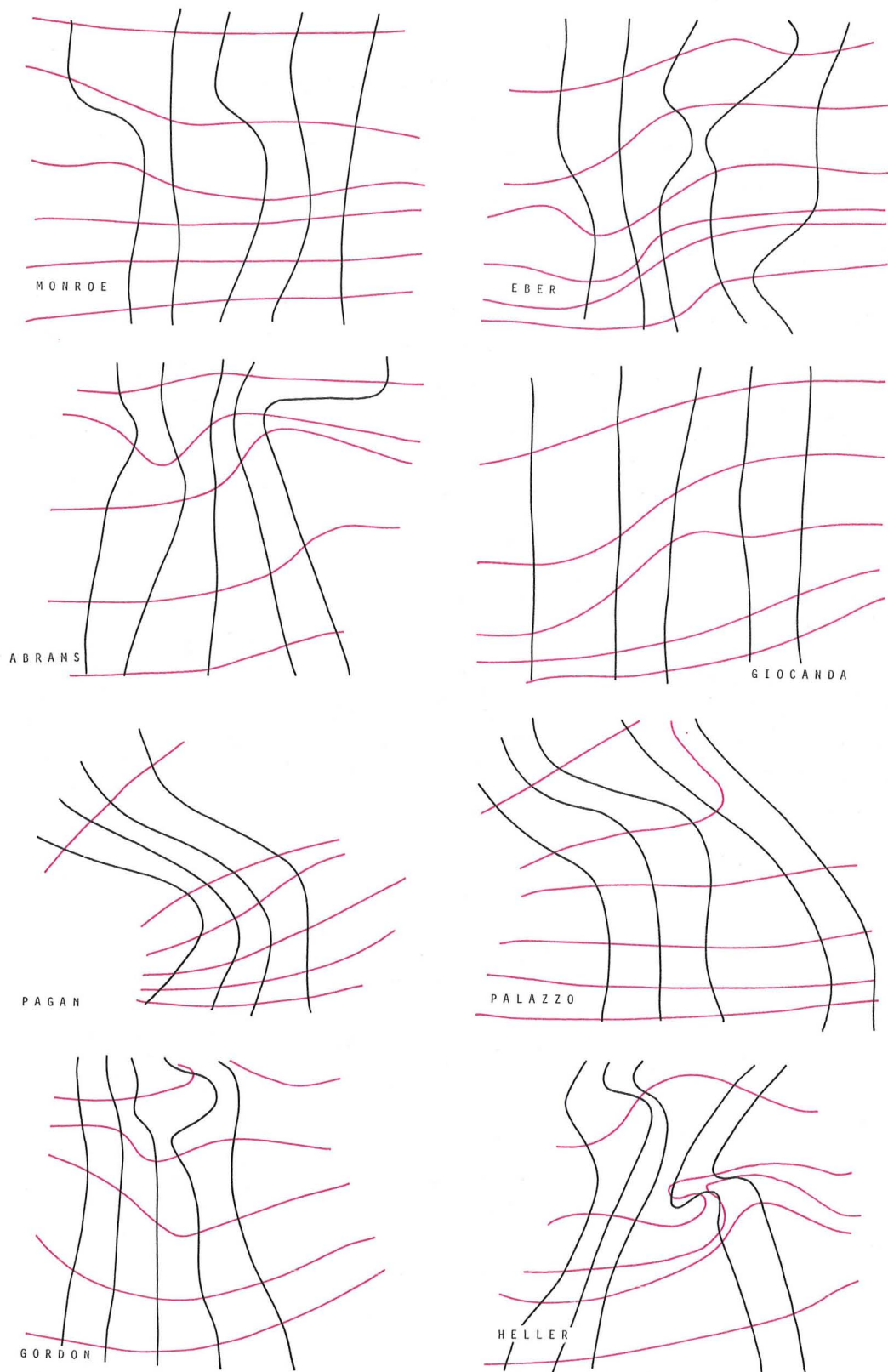


Figure 17.9 Transformations of the second Paris maps.

four, having produced amazing approximations of the reference grid. Paris is a p-peneplain on the second and third map set and extraordinarily flat on the first. It is a different city than London and Rome when it comes to cognitive organization.

* * *

On the fourth try the three kids revert to form. Pagan and Casyk are back in class one and Eber is in class three. Pagan has simply overloaded her map with detail she couldn't possibly keep straight (though the bulk of her map consists of a decent grid) and Eber, whose map runs from the Bois du Boulogne in the west to the Bois des Vincennes in the east, produces a grid with a local variation caused by misplacing the Champs de Mars on the Right Bank instead of the Left.

* * *

Admitting the tenuousness of the classifications used to sort the maps, I still intend to use them. You have seen the data and watched me sort it out, kid-by-kid and class-by-class. Check me if you disagree with any of the foregoing sortings—to a substantial extent—no little quibbles, because what I want to show is the number of kids expressed as a percentage in each of the four classes for each city.

TABLE 17.0

THE GRID TRANSFORMATION
CITY-SORTER

	CLASS 1	CLASS 2	CLASS 3	CLASS 4	TOTAL
LONDON	n-25 39%	n-9 14%	n-16 25%	n-15 12%	n-65 100%
ROME	n-18 38%	n-9 19%	n-16 33%	n-5 10%	n-48 100%
PARIS	n-7 20%	n-7 20%	n-9 27%	n-11 33%	n-34 100%

The results are unequivocal. If the ability to approximate the reference grid can be taken as a measure of naive veridicality or at least extra-group consensuality, then it can be taken as a measure of legibility.

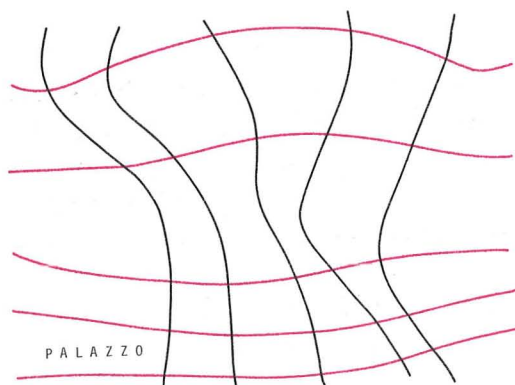
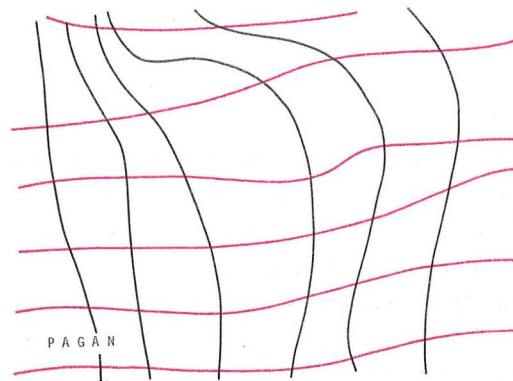
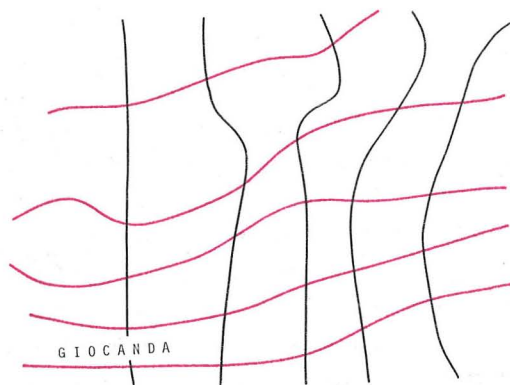
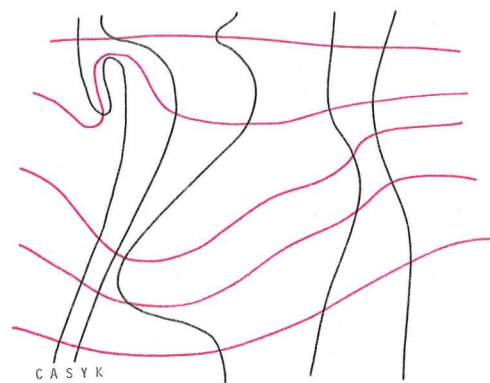
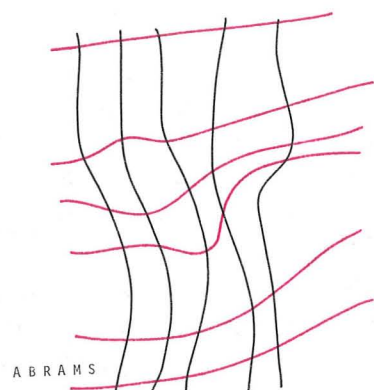
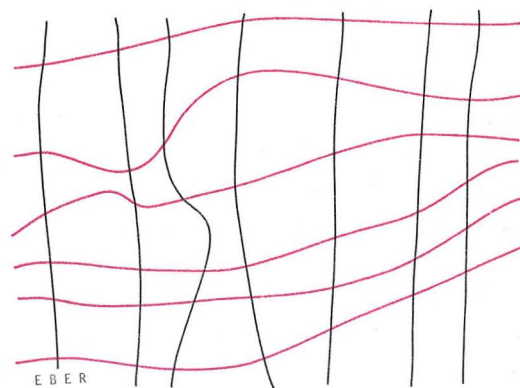
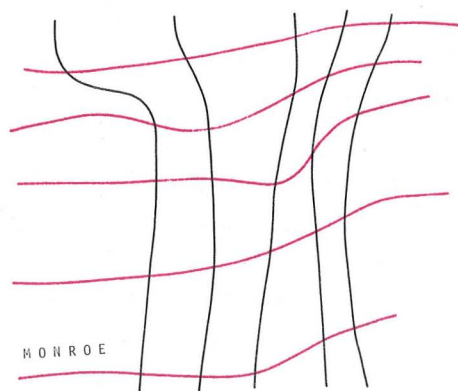


Figure 17.10 Transformations of the third Paris maps.

A legible city is that city capable of being read and being read means being able to in some way reify incoming material. "Do you read me?" "Loud and clear?" Great, because what our analysis shows is that Paris—for whatever reason—was being read more loudly and clearly than London or Rome. My personal predilections would be that Paris was the most legible city, and so it was, but further that London was much more legible than Rome. But nothing bears out this latter predilection, so I fear my personal predilections don't have much to do with this. Look at the table.

In percentage terms, Paris has three times as many class four mappers as does Rome or London, and nearly half as many class 1 mappers. London and Rome have fewer class two mappers, but then go back and compare a class two Paris map with a class two map of Rome or London. If I have stacked the deck, it's been against Paris. All three cities have similar numbers of class three mappers, but Paris is able to generate that added inch of clarity that makes all the difference. Nor do these results stand alone. They are supported by three previous analysis techniques that spoke directly to the issue of imageability or legibility. And in each case Paris had the most imageable elements or the most heightened legibility.

Why am I so excited about these results? Because I think that the three techniques in combinations—content analysis, the analysis of isolated elements, and the grid transformation analysis—have been able to address the issue of legibility seriously. None of them do the task alone. Content analysis does not show us anything about space. Analysis of isolated elements does not show us anything about content. Grid transformations ignore isolated elements and content. But together they make beautiful music. Together they address a significant number of those elements that go to make up the cognition of space, neither form nor content, but form and content.

There is another element and that is the personal element. Cognition of space is not a group phenomenon, but an aspect of personality. In the pseudograph analysis we established five strategies that could be used to organize the space of a city through time and clearly showed the futility of addressing the question of cognition or the question of urban imageability employing a single map per respondent. In that analysis we looked at each kid's product through time. Well, the kids and the product are with us once again. What can we say about them?

We would have liked to have been able to show a trend for each kid from a highly distorted approximation of the reference grid on the first attempt to a perfect reproduction of it on the final attempt. But we can

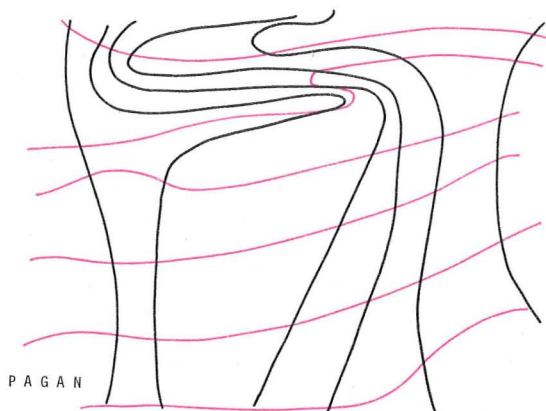
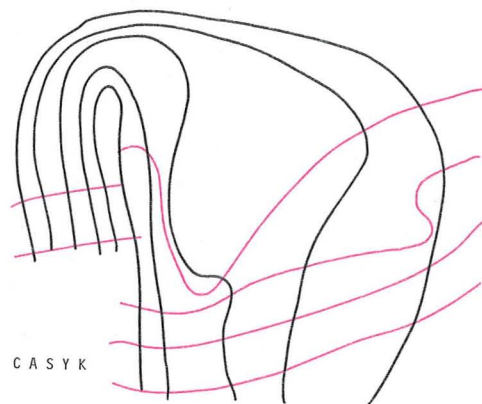
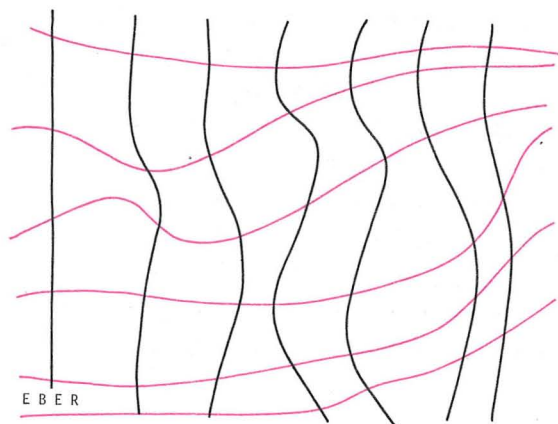


Figure 17.11 Transformations of the fourth Paris maps.

show nothing of the sort. The kids did not change much from set to set in their ability to approximate the grid. After a few sets of maps, you sort of anticipated that a given kid would fall into a given class and were shocked—at least I was—when, for instance, Pagan popped up in class four in Paris. We were so used to seeing her in class one, and Lincoln in class one and Cruz in class one and Nash and Abrams and Watson in class four. The consistency was very great, and as a consequence I assessed the average class for each kid. Below I have ranked them according to this average and the average itself is shown. I don't think there are any surprises, but the information will be valuable to compare with other rankings of the kids that we shall soon be seeing.

TABLE 17.1

GROUP L RANKED ACCORDING TO GRID TRANSFORMATION

Hendricks	1	Eber	2.3
Gray	1	Mayo	2.5
Seward	1	Palazzo	2.6
J. Brown	1	Giaconda	2.7
Cruz	1	Heller	2.8
Lincoln	1.1	Baker	2.8
Casyk	1.2	Montaigne	2.8
Noyes	1.3	Bloch	2.8
Jencks	1.5	Monroe	3
Fisher	1.5	Needham	3
Pagan	1.6	Lenz	3
Jones	2	Watson	3.1
Portman	2	Nash	3.3
Jaechel	2	Pierce	3.5
G. Aiken	2	Abrams	3.7
B. Brown	2.3	Prinz	4
Gordon	2.3	Wood	4

The only kids on the ranking that I would want to really exclude from the list would be Prinz, Portman and Jones, simply because we have too few maps. But I will leave them for the time being since it is the best we have. The meaning of the ranking is fairly obvious. The higher you rank, the greater the consistency with which you produced a map of the closest class. Due to the regularity with which most kids appeared in a single or adjacent class, I tend to view the average class figure, less as an average than as a class assignment number. Thus Miss Bloch did not appear often in class two and four to

achieve her average of 2.8, but rather spent most of her time in class three with a dip on a single occasion to class two. A few were all over the board, like Giaconda and Palazzo, but most of the time the average class number says where you were, not where you weren't.

Since the ranking will mean most in conjunction with other similar rankings, I will delay its discussion until that time. I have included it at this point to make luminously clear the possibilities of the analysis technique for going both ways—speaking about the city and speaking about the kid. It would seem apodictive, given the nature of the data, that it could go both ways, but such is the perversity of the human being regarding his handiwork that he seldom realizes its dual character: that it speaks of the human being while it speaks of the environment. A map does this perhaps more articulately than any other artifact of man. It is, literally, of the world and of man.

V

This chapter may have seemed forever, but it was necessary. It has jumped the last major hurdle standing between the student of mental maps and his goal of understanding. All the pieces but one are now in place. That comes next. But before finishing, what have we done in this chapter?

I will not bore you with a recital of the defects of the arrangements of London and Rome that we have uncovered. I will not bore you with a discussion of p-geomorphology. I will not try to erect a genetic sequence of the development of map projections. There is nothing to support it. What we have done outstandingly well in this chapter is point out directions to be followed, directions I could have followed, were life quite as long as art, but directions others must take instead.

- 1) Assuming the possession of a decent data set such as we possess in this study (the data sets elicited by instructionless mapping will get nobody anywhere) it would be possible to regard the grid transformations as legitimate projections and analyze them rigorously. This we have not done, and could be profitably accomplished using the techniques available to the professional cartographer. Conceivably these will lead to a rigorous classificatory system for application to mental maps that will avoid the lackluster and naive designations of earlier students of mental maps (survey, net, route, area types) or our desultory descriptors of good and bad approximations of a reference grid. Our analysis has shown, if nothing

else, that more is involved than was thought, and that consequently more is required than present energy available. It could be fun and interesting.

- 2) Assuming a decent set of grid transformations such as we possess, it would seem to be valuable to plumb geomorphology for all it's worth as a descriptive language of wide application to developing surfaces of all sorts, but particularly mental maps. Unfortunately, I lack the knowledge and understanding of the field necessary to have pulled off a decent use of a beautiful language, and have likely been the cause of no little merriment in my use of technical terms. But if I have been lacking in wit myself, let me, like Falstaff, be the source of wit in others.
- 3) Assuming a decent set of grid transformation such as we possess, it would be possible to achieve one of the dreams of the student of mental maps: the construction of a mental base map. The simplest approach would be to use a median projection, such as from class two or three, and project the content analysis, not on a standard map, but rather on such a median projection. This would be better than what we have. Better still would be the construction of a mental base map that would in some way average out or incorporate all of the significant deviations that appear.