CHAPTER 15

I am no artist. A neat and intelligible drawing
is the utmost that I can produce. But even this
modest degree of achievement may be very
useful, as I have discovered many a time in the
laboratories—indeed, I have often been surprised
that the instructors of our youth attach such
small value to the power of graphic expression;
and it came in usefully now, though in a way that
was unforseen and not fully appreciated at the
moment.

. ... R. AUSTIN FREEMAN
A Silent Witness

I

Whereas content analysis allowed us to investigate the group
reaction to the environments of London, Rome and Paris with particular
regard to the imageability and legibility of these environments, the
analysis attempted in this chapter will allow us to examine the individual
kids' ability to weave a connected network out of these environments.
While the content analysis could have been just as successfully employed
to investigate mere lists of places, the present analysis will probe the
degree of connectivity between these listed places in the spatial dimension.

The map instruction schedules in Chapter 3 indicate that the
method we tried to teach the kids should have resulted in maps that were
completely connected. That is, each of the landmarks located should be
connected to another by a line. One of our hopes (it was too hopeful to be
considered an actual hypothesis) was that, through time, the number of
lines connecting each landmark with another would increase. In other
words, if in drawing the first map, only one route between two points were
drawn, on the second map an alternative route would appear, on the third,
a third route, and so on. Increased environmental literacy would result
in a map with enhanced connectivity. The question was: does an analysis
technique exist that would allow us to test our contention in a reasonable
fashion?

Yes, such a technique exists and is well developed. Graph
analysis answers our needs perfectly. Graph analysis, an applied case
of graph theory, is a rather recent offshoot of a rather recent concern of
mathematics. Most graph theoreticians trace the origin of their interest
to a paper published in 1736 by Leonhard Euler (see Ore, 1962, ix). The
paper, called "The Seven Bridges of Konigsberg," deals with the famous
puzzle most of us have seen at one time or another, wherein we are to
trace a path such that we shall cross each of seven bridges once, but only
once. In solving this particular puzzle, Euler also solved the general
case and in so doing created the first floor of a by now amazing mathematical
structure. He opened his paper as follows:

> The branch of geometry that deals with magnitudes
> has been zealously studied throughout the past, but
> there is another branch that has been almost
> unknown up to now; Leibnitz spoke of it first,
> calling it the "geometry of position" (geometria
> situs). This branch of geometry deals with relations
> dependent on position alone, and investigates the
> properties of position; it does not take magnitudes
> into consideration, nor does it involve calculations

with quantities. (Euler, in Newman, 1956, 573)

Euler's interest in the geometry of position lay dormant for nearly a hundred years, when, in the middle of the Nineteenth Century, the thread was once again picked up. When it was picked up, it branched into two threadlets, deeply interconnected, yet distinct: topology and graph theory. Both took off from Euler's general solution to the problem of the seven bridges of Konigsberg, which also turned out to be a powerful tool for the investigation of polyhedra. A polyhedron is a solid whose surface consists of a number of polygonal faces, and Euler's formula reads:

$$V - E + F = 2$$

where V denotes the number of vertices, E the number of edges and F the number of faces. In proving Euler's formula, Courant and Robbins write:

> ...Let us imagine the given simple polyhedron to be hollow, with a surface made of thin rubber. Then if we cut out one of the faces of the hollow polyhedron, we can deform the remaining surface until it stretches out flat on a plane. Of course, the areas of the faces and the angles between the edges of the polyhedron will have changed in this process. But the network of vertices and edges in the plane will contain the same number of vertices and edges as did the original polyhedron, while the number of polygons will be one less... since one face was removed. We shall now show that for the plane network, $V - E + F = 1$, so that if the removed face is counted, the result is $V - E + F = 2$ for the original polyhedron. (Courant and Robbins, in Newman, 1956, 581)

To me, nothing could be more obvious than that at this point in their proof, Courant and Robbins are actually dealing with a sketch map produced by the kids in Group L using the point-line-area method. The vertices are our points, the edges are our lines, and the faces are the areas enclosed by the lines. Fortunately, it is not necessary to follow the development of topology and graph theory from this simple beginning to the elaborate mechanisms that exist now. Although their application to mental maps is novel in geography, the use of these techniques is well established, particularly in the investigation of transportation networks. Summaries of the use of graph theory appear in Kansky (1963, Haggett (1965), Chorley and Haggett (1967), Cole and King

(1968), and so on. The technique has found profitable use in geography.

Unfortunately, of all these summaries only Kansky's is adequate for the beginner, because the other discussions demand prior familiarity with the foundations of graph theory before they can be used. While they all discuss the Alpha, Beta and Gamma indices, and mention the concept of "graph diameter", while a few even define the cyclomatic number, and while they all show the usefulness of these measures in application to airline and railroad and river networks, none of them, with the exception of Kansky, make explicit the nature of the minimal graph, clearly distinguish between a graph and a subgraph, or provide adequate criteria for the distinction between planar and non-planar graphs on theoretical grounds. Furthermore, among the summaries noted there is a massive inconsistency in terminological usage which makes cross reference between them difficult (and for a complete picture, cross reference is a must). Finally, the ultimate blow, none of the terminology used by the geographers bears the faintest resemblance to that used by Oystein Ore, whose Theory of Graphs (1962), remains the best mathematical summary of the field in English.

Nonetheless, depending solely on Ore, I was finally able to commence analysis of the Group L maps. The first map I tackled has been previously reproduced as Figure 14.0. As reference to this figure will show, it consisted of single points floating in space, single unterminated lines floating in space, points embedded in floating lines, as well as a series of points and lines connected together. Since I wished to consider the entire map as a graph, it was necessary to deal with all the elements displayed. According to the rules of graph analysis I was forced to consider each free-floating element as a subgraph. Further, I was constrained to consider each line, whether free-floating or not, as an edge or line; to consider each point, free-floating, denoted or intersection, or unmarked intersection, as a vertex; and to count as areas only those spaces bounded by lines. It was sufficient to calculate the cyclomatic number for only seven maps to understand that something was leading me astray.

The results obtained from the analysis of these first seven maps were wildly contradictory. I was obtaining impossible results for planar networks. I continued to vary the criteria until I discovered the root of the problem. In graph theory a link or an edge is a special line. It may be seen as the edge of a solid figure, or a link between two points, but never simply a line, as sketched by Lana Monroe or as understood in Euclidean geometry. In graph theory, all lines are terminated finitely by points. In fact, graph theory is not really concerned with lines at all, but quintessentially with points. Ore writes:

> The first problems in graph theory dealt with
> configurations of points with lines joining
> them. In these configurations it was immaterial
> whether the lines were straight or curved
> continuous arcs between the endpoints; whether
> they were long or short. The fact that they
> connect two given points is the only essential
> element. (Ore, 1962, 1)

He is even more explicit for his definition of a graph reads: "There shall
be a set V consisting of the points which shall be considered to be connected
in some fashion" (Ore, 1962, 1). The only other allowable graph definition
is that of a null graph which is to consist of a set of points V connected in
no fashion whatsoever. But nowhere in graph theory or graph analysis is
there room for finite lines connecting nothing, or unterminated by the
points which are the proper subject of the theory.

So the solution of my problem was simple. All I had to do to
be able to apply graph analysis to my maps was to assign a point to the
end of every unterminated line. I could easily consider the floating points
to be null subgraphs. I did so, reanalyzed the seven maps and obtained
consistent results. It was smooth sailing, except that I gagged every time
I assigned an endpoint to an unterminated line. The act seemed to me to
be thoroughly illegitimate. Why? Consider the act of mapping and the
significance of the points. The points on our maps are not abstractions,
but in fact symbols for actual landmarks, buildings or places with unique
characteristics. Likewise our lines are not abstract connections between
these points, but symbolic of actual streets, rivers, bridges and so on.
The question is: is there an implied and intended distinction between a
line ending in a point, and one not ending in a point from the point of view
of the kid drawing the map? The obvious answer is "Yes." The drawing
of an unterminated line means that the mapper is aware of the existence
at that spot of a linear phenomenon, but that he is unaware of the nature of
the endpoints of that phenomenon. Thus one may cross Oxford Street and
be aware that Oxford Street continues in a linear fashion in two directions
from the point of intersection, without being aware of anything else about
that street. So, whenever I assigned an endpoint to a floating, or other-
wise unterminated, line I was imputing knowledge to the mapper that was
not, in fact, there. Furthermore, it could get out of hand. Thus on
Monroe's first map (Figure 14.0) I was forced to assign eleven points
before I could continue with the graph analysis. On other maps the number
of added points was much higher. If, however, I abandoned this process
of adding points, I would at the same time abandon the possibility of using
graph analysis, a technique of great promise. I could, of course, continue
to use graph analysis to analyze those portions of the sketch maps consisting

of legitimate subgraphs, but this would be an analysis, not of the maps as a whole, but of parts of the map arbitrarily segregated by the demands of a mathematical theory. The question was simple: was I to interpret my data in the light of an analytical technique, or was I to find a technique that could handle data as it came from the pencils of Group L?

The answer was also simple. I abandoned graph analysis as a useful tool for dealing with the maps as wholes.

II

Nonetheless, there was a valuable distinction that needed to be made in regard to the varying degrees of connectivity that obtained among the various maps of any individual, among the various individuals, and among the maps of the three different cities. Was there any way to achieve the ability to make these distinctions without engaging in further illegitimate activities? It occurred to me that the issue of connectivity was closely related in the case of mapping to knowledge, and I considered ranking the various graph-like elements that were causing me problems in order of the amount of knowledge needed to draw the various elements (meaning the free floating points, the free floating lines, and so on, each being considered a specific type of graph-like element). The basic assumption involved here is that a more highly connected map somehow involves a greater awareness of the relations of the map content than otherwise. This assumption is open to question, but my reasoning was as follows.

The simplest thing one could place on the map surface was a single isolated unconnected point. This point generally represented a single landmark, and awareness of any number of isolated landmarks could result from a comparatively passive sightseeing experience. Thus, the kids were ferried around in the bus, taken to a number of landmarks, and allowed to see and explore them. In most cases these landmarks were already part of the kids' cognitive systems. Then the kids got back on the bus and were magically conveyed to another landmark. Most experience can be disintegrated into a number of points.

Now, what is involved in placing these points on a map? They could be scattered helter-skelter on the map, or meticulously located vis-a-vis one another. But as long as the points were not connected by lines of any sort, only two sets of discriminations were really necessary on the piece of paper: the point had to be located in the horizontal dimension, and then in the vertical dimension. Period. This seemed to me to demand the minimal input from the mapper, demand the least knowledge, and involve the lowest level of connectivity.

Then consider the question of the free floating line. The experience necessary for a line is greater than that for a point, if only in the sense that linear experience is composed of pointilistic experience. Further, the experience, and the subsequent drawing of the line, involves more than location in the vertical and horizontal: it involves sequential decisions which result in the line having bearing and extent, attributes which do not pertain to a single point. It seemed that the free floating line demanded greater input from the mapper, demanded more knowledge, and suggested a higher level of connectivity—if only implicitly.

A free floating line terminated by a point constitutes the next step in the series. It demands more knowledge (ability to associate the landmark with the street), and hence greater input from the mapper, but it is also definite evidence for the first time of connectivity per se. If all that is demanded in the case of a point is recognition of a landmark, and all that is demanded in the case of a line is an aggregation of pointilistic phenomena, then a line terminated by a point means that out of the series of points composing the line one has been singled out as being crucial for an understanding of the linear phenomenon in question. Or, conversely, that the line is in some sense critically involved in the understanding of the point. In any event, two different realms of geographic knowledge are being linked.

Following the same line of thought it occurred to me that if the point were embedded within the line, rather than terminally attached, we were then in the presence of yet a higher order of discrimination. The line terminated by a point could be seen representing this situation: the kid recognized a landmark and further recognized that the street ran away from (or toward) the landmark in a given direction. In the case of the point embedded within the line the kid recognized that the street ran away from (toward) the landmark in two directions. In terms of connectivity, the line terminated by a point suggests the connection of that point with one other point, presumably to be found at the other end of the line, while the line embedded with a point suggests connections with that point at both ends of the line, and hence greater connectivity.

In the four cases mentioned so far, however, while there is some hint of connectivity in the graph theory sense, there is in fact no real connection of two separate points. A map could consist of these four icons without showing any connections among them. But basically we could rank maps that consisted solely of such icons already. Thus a map consisting solely of unconnected points could be taken as implying less connectivity than one consisting entirely of lines, which in turn could be taken as implying less connectivity than one consisting completely of lines terminated by points, which could be taken as implying less

connectivity than one consisting totally of lines with embedded points. These free floating icons comprised an enormous portion of the things drawm on our maps, and none of them fell within the province of graph theory.

The obvious next step was to consider a line terminated at both ends by points. Such an icon was connected, both in the graph theoretic sense and in the sense that the kid had recognized two landmarks and recognized and drawn a real relation between them. In this instance, connectivity was not implied, but demonstrated. That seemed to be the end point of my hierarchy. I was troubled, however, by the following seemingly more involved icon, namely a line with two embedded points: ●—●—— . The problem was that this assemblage implied greater connectivity than a line terminated by two points, and yet the line utterly terminated by two points seemed to be finally connected, to comprise a definite unit, to constitute a well-rounded remark about the connectivity of two points, while the line with two embedded points, while being as connected as the other in regard to the two points, seemed to trail off indefinitely, implying, at least to me, that the mapper had less complete knowledge of the environment in question. The issue is more meaningful in the form in which it generally arises on the sketch maps themselves. Which of the following is the more connected: this _____ or this _____ . Rephrased in this manner, there can be no question that the first evinces the greatest connectivity. It constitutes a total, closed set of remarks about six landmarks and six streets. The latter constitutes, on the other hand, an open, partial set of remarks about four landmarks and six streets. The former is more connected, the latter less so. As can be seen, the line terminated by two points is merely a special case of the first drawing, while the line with two embedded points is a special case of the second drawing. Arguing from the more general case, I finally decided to consider ●——● as more connected and hierarchially higher than —●—●— . This latter icon in all of its manifestations has been called a trailing subgraph, whereas the former has been termed an actual subgraph, since it is the only one of the six icons so far isolated that would be considered a subgraph in graph theory.

This brings us to the end of my mental peregrinations. I have isolated six combinations of points and lines, ranging from minimal connectivity (in the case of free floating points) to maximum connectivity (in the case of the actual subgraph), without delving into the degree of connectivity as it might vary from actual subgraph to actual subgraph. (Note that graph theory would have allowed me to rank subgraphs. For example it would allow me to assess this ▱ as more highly connected than this ◰ since there are more connections per point in the former than in the latter. I decided not to pursue this route,

LINE WITH EMBEDDED POINT

POINT

LINE WITH TERMINAL POINT

LINE

• Baker ST

Liverpool

Oxford•   totten ham   Euston ROAD   St Pancreas

carnaBey Street   trefalGar SQ.   GPO   Ferry Hes.   MaRLton RoaD

PicaDilly

St.Pauls

Buckingham PALACE   West Minister   10 Downing Street

            Mabey

BIG Ben   Victoria Em.   White Tower

thames River   London BRIDGE

Chelsea

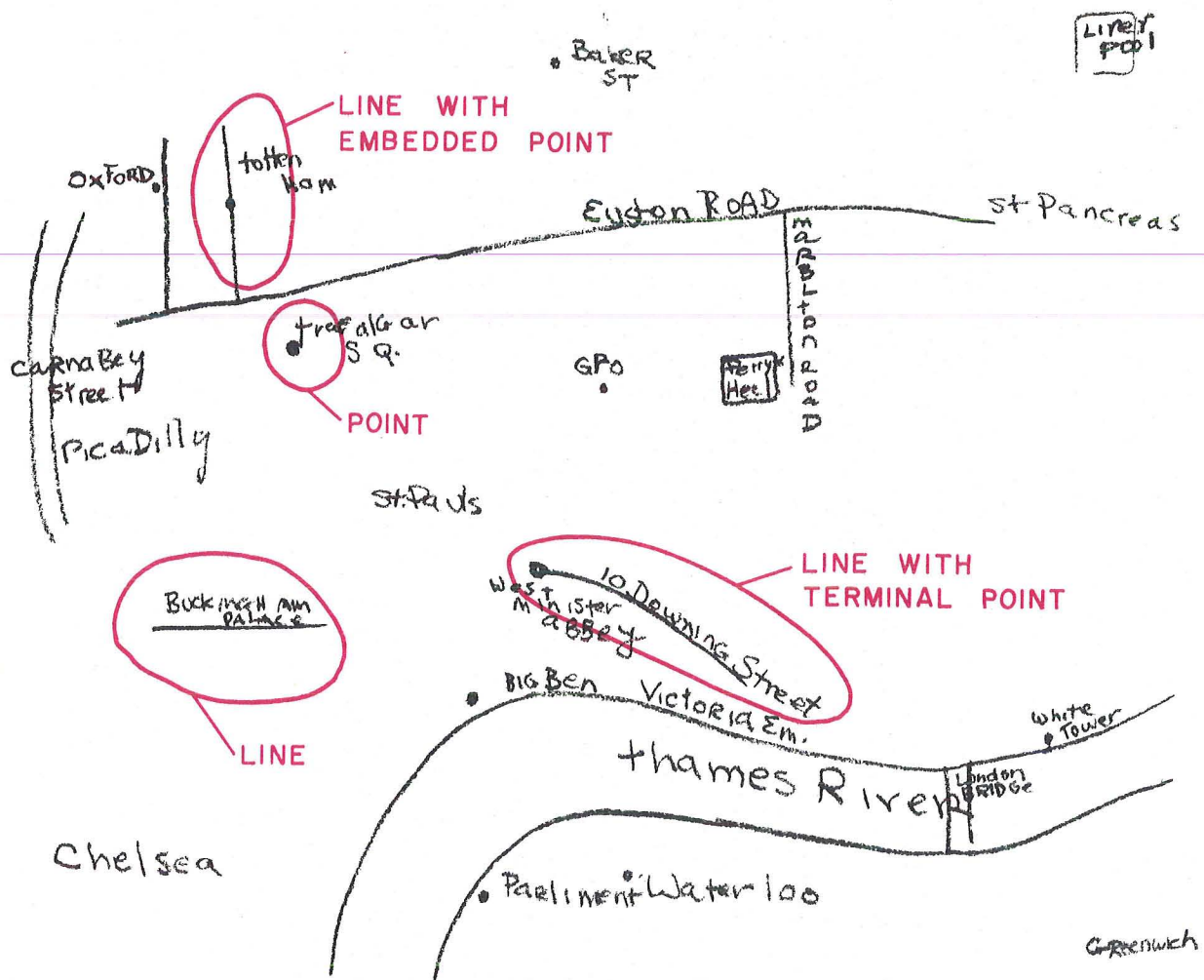• Parliment Waterloo   GREENWICH

Figure 15.0   Leslie Casyk's third London maps showing the following
pseudograph elements: point, line, line with terminal
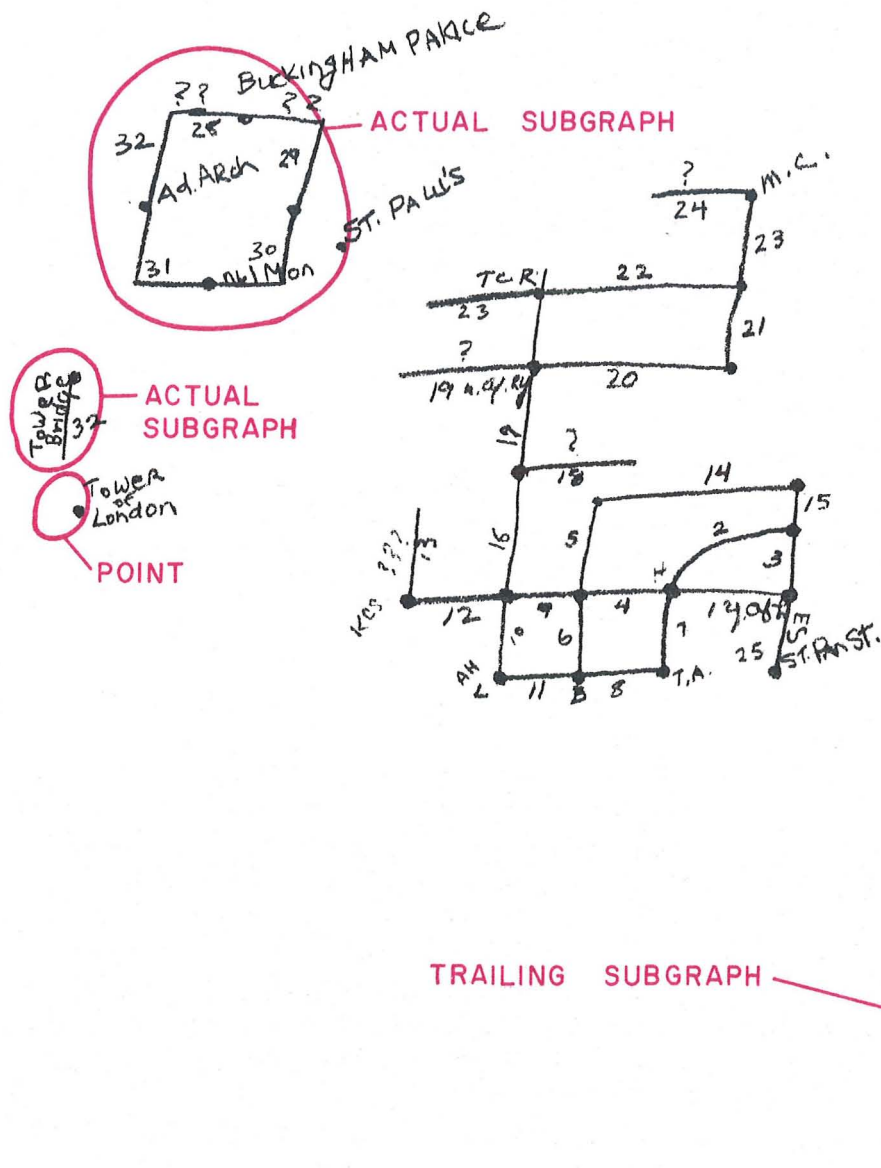point and line with embedded point.

Figure 15.1   Tracy Cummings' first London map showing the following
pseudograph elements: point, trailing subgraph, actual
subgraph.

inasmuch as the actual subgraphs amounted to a small portion of the icons found on the maps. Such a ranking would add little to an overall understanding of the maps as a group.) These six icons shall be hitherto termed the pseudograph elements.

Two issues remained. The first of these was to discover whether or not the six pseudograph elements isolated covered all of the possible configurations found on the kids' maps. Figures 15.0 and 15.1 show two maps with several of the elements isolated. All the maps were examined in this fashion and none of them was found to contain any but the six pseudograph elements considered above.

The second issue was to invent a mechanism for dealing with these pseudograph elements in a quantitative manner that would allow us to assign a single number to a given map. To that end, three simple devices were settled on. The first measure was a simple enumeration of the number of pseudograph elements on a given map. The second was to work out an index of fragmentation. The third was to provide an index of average element complexity. These three indices are considered individually below.

1) Number of Elements. This entailed nothing more than counting the number of A) points, B) lines, C) lines with terminal points, D) lines with embedded points, E) trailing subgraphs, and F) actual subgraphs. Thus if a map consisted of six points (P), it had a number of elements (NE) of 6. If, on the other hand, it consisted of one each of the pseudograph elements, it still had an NE of 6. Thus, the NE simply notes the number of pseudograph elements on a map and makes no remarks about their connectivity. However, as will be seen, it is nonetheless a powerful guide to the map. The maps of David Abrams, for example, seldom had an NE much greater than 1 or 2, but these were both actual or trailing subgraphs. On the other hand Erica Cruz usually came up with very high NE's, for her maps contained nothing other than free floating points or lines. Thus while the measure seems deceptively simple, due to the nature of the pseudograph elements being counted, it actually contains a great deal of information. This will become clearer as we examine the results of the analysis.

2) Fragmentation Index. This entailed a great deal more than simply counting, and yet is quite simple. Each of the map pseudograph elements was weighted, entirely arbitrarily. Since a map consisting entirely of free floating points was obviously more fragmented than a map consisting of a single actual subgraph (AS), and since we wanted to assess degree of fragmentation, it was decided to weight the pseudograph elements more heavily as they were simpler in nature. Thus each P received,

arbitrarily, a weighting of 6, each line (L) a weight of 5, each line with terminal point (LTP) a weight of 4, each line with embedded point (LEP) a weight of 3, each trailing subgraph (TS) a weight of 2 and each AS a weight of 1. It was then a simple matter to calculate the fragmentation index (f):

$$F = 6(P) + 5(L) + 4(LTP) + 3(LEP + 2(TS) + 1(AS)$$

As index of integration could then simply be calculated by taking the reciprocal of F (100/f   i). The objection that these weightings are quite arbitrary is readily admitted and yet is not considered a serious drawback to the general scheme. It is now entirely possible to assess each of our maps and assign to it a number that readily classifies it, if not uniquely, at least sufficiently from other maps for our purposes. Note, for example, that a map that consists entirely of a single AS would have an F of 1, while a map that consisted of 100 P's would have an F of 600. All the maps can be assigned similar numbers and ranked along a continuum running from total integration to open-ended fragmentation.

I doubt that it has escaped notice that the fragmentation index continues to rise with each additional pseudograph element. Thus a map consisting of fifty P would have an f of 300, while one consisting of five P would have an f of 30. Now, these two maps are equally unconnected, and yet they show different F's. Thus the F rates two equally fragmented maps differently, or, in other words, penalizes a mapper for each additional pseudograph element added. While I still feel the F to be a significant measure, this objection has weight, and it was in an attempt to come to grips with this that a third measure was invented.

3) Average Element Complexity. The index of element complexity (EC) was nothing more than an assessment of the average pseudograph element:

$$EC = F/NE$$

Thus, given a map with 8 P and 1 TS we would have an NE of 9 and an F of 50:

$$NE = 8 P + 1 TS = 9$$

$$F = 6(P) + 5(L) + 4(LTP) + 3(LEP) + 2(TS) + 1(AS)$$
$$F = 6(8) + 5(0) + 4(0) + 3(0) + 2(1) + 1(0)$$
$$F = 48 + 2$$
$$F = 50$$

$$EC = F/NE$$
$$EC = 50/9$$
$$EC = 5.6$$

Now, of course, none of our six pseudograph elements has a value of 5.6, but the P has a value of 6 and the LTP a value of 5. Thus, the average complexity of the pseudograph elements on this map falls on the P side of a mythical pseudograph element midway between P and LTP. A map consisting of a single AS would have an NE of 1, an F of 1, and hence an EC of 1. The EC of 1 says simply that the average complexity of the pseudograph elements on this map is on the order of an AS.

The EC resembles the NE and the F in its ability to tell us something about the nature of an individual map. It is at once informative without being definitive. It is, however, the most definitive of the three measures discussed, though once again, this is true only within the confines of our particular data set. Thus a low EC does not necessarily imply a low NE but a low EC is never found on our maps without a correspondingly low NE. Thus, if a kid has drawn a map with an EC of 1, it invariably means, not that he has drawn any number of complete AS, but a single AS. As a rule, a great number of pseudograph elements tends to imply a great number of free floating points and lines. But this will become clearer as we investigate the results of this pseudograph analysis.

The application of this analytic technique uncovered a number of unanticipated problems, especially in regard to the criteria used to categorize map icons into the six pseudograph elements established above. For a complete awareness of what was involved, it seems vital to establish explicitly the criteria that were finally adopted. These are described below, pseudograph element by pseudograph element.

1) POINTS. A point is that thing on a map without linear, graphic or verbal characteristics. It may be simply the name of a point phenomenon (e.g. Soho Square) without associated graphic point (.) or a point with associated verbal tag (.TL) or an unidentified but obvious point (e.g. an unlabeled point next to Hughes Parry Hall and Cartwright Gardens which was obviously Commonwealth Hall) or a pictographic drawing (as of, say, the Tower of London). To consider a simple name a point, that name must appear on our point list or be capable of inclusion on that list. Thus "Carnaby Street" as a free floating phrase without associated graphic depiction, would not count as a point, but rather as a line. Names of areas were not considered in this analysis at all. The point must not be in any way connected to other elements such as lines.

2) LINES. A line is any labeled or unlabeled or simply verbal linear element with no terminal points, no embedded points, and no intersections. The line need not necessarily be a simple straight line and so may appear either ——— or ⌣——— and so on. However, a line that appears ⎍——— , is treated as a trailing subgraph even when the apparent vertices are not either identified by points or labeled. Readily identifiable bends, when correlated with items in the environment containing such bends, should be counted as trailing subgraphs in that they demand discriminations in looking and in drawing, equivalent to the discrimination necessary to become aware of and draw an explicit trailing subgraph. Examples of such bends would be those in the Thames, Tiber and Seine, the curve in Regent Street, the bends in the Via Veneto, the changes in direction of the Boulevard St. Germaine and so on. The difference between a smooth, shallow curve and these sorts of trailing subgraphs is completely a matter of subjective perception of degree, and is not susceptible to more objective definition. Fortunate it is, then, that such cases are relatively rare (most rivers have associated with them bridges which make them de facto trailing subgraphs).
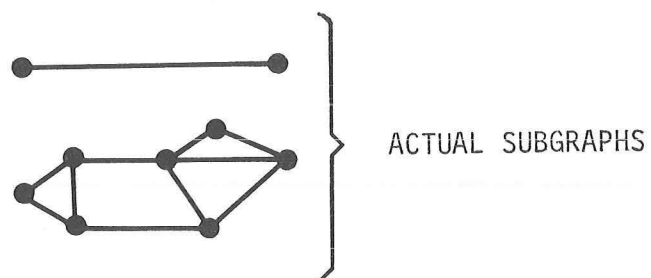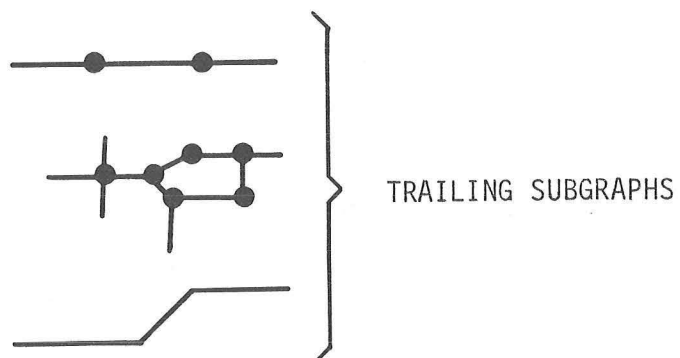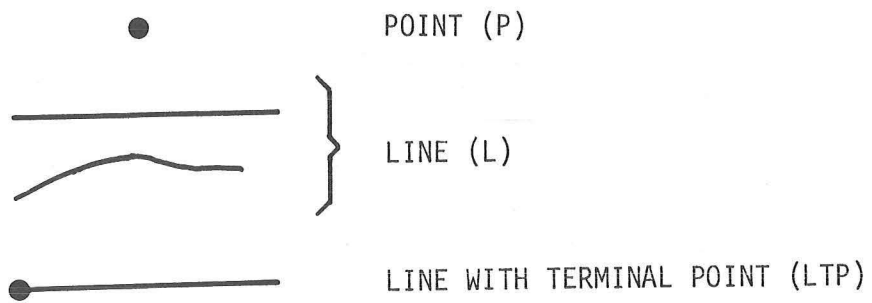
3) LINES WITH TERMINAL POINTS. The criterion for these is a line (as above) terminated explicitly with a graphic or verbal point (likewise, as above).

4) LINES WITH EMBEDDED POINTS. The criterion for these is a line with associated point located on the line anywhere but at the ends.

5) TRAILING SUBGRAPHS. A trailing subgraph is that compage of points and lines in which at least one of the lines is not terminated explicitly with a point, either graphic or verbal.

6) ACTUAL SUBGRAPH. This is a compage of lines such that each line segment is terminated by either an explicit point, graphic or verbal, or by the intersection of that line segment with another line segment. In other words, intersections of lines are counted as points within an actual or trailing subgraph.

The entire technique is summarized in Figure 15.2. Reference to this figure during the discussion of the results will be helpful. The discussion is divided into two basic parts. First we shall distinguish classes of mappers based on the pseudograph measures, and sort the kids into the relevant classes. This first section will be concerned with problems of personality and motivation as they effect the maps. The second will deal with aggregations of the pseudograph measures and will

POINT (P)

LINE (L)

LINE WITH TERMINAL POINT (LTP)

LINE WITH EMBEDDED POINT (LEB)

TRAILING SUBGRAPHS

ACTUAL SUBGRAPHS

NE = Number of Elements

$f = 6(P) + 5(L) + 4(LTP) + 3(LEP) + 2(TS) + 1(AS)$

$i = f/100$

$ec = f/NE$

Figure 15.2   The six pseudograph elements and pseudograph measures.

examine the effect of the environments on the maps. Thus, the results of this chapter will be concerned with personality, motivation and environment as these relate to the maps.

II

Figure 15.3 shows the results of the pseudograph analysis for those individuals completing at least three maps of London. Shown in blue is the fragmentation index, in black the number of elements, and in red the average element complexity. The scale is in the same color as the appropriate line. The merest glance will reveal one thing: that as far as the pseudograph measures are concerned, the maps produced by the kids in Group L are highly variable, both from kid to kid, and for the most part from map to map for nearly any kid. If this measure shows us nothing else, it does show that the kids in Group L were individualists when it came to drawing maps.

A closer examination begins to reveal a certain order. If we concentrate on only one of the measures, the fragmentation index (shown in blue), things will be simpler. A line can connect three points in only nine ways. It can make a straight level line, or it can go up, or down, or up and down, or down and up, or straight and then up or down, or up and down and then straight. There are no other possibilities. Considering these possibilities we can discriminate and thereby reduce the number of possibilities from nine to five. This will be more manageable and reasonable, given our sample size. The five classes (or possibilities) are described below.

1) The fragmentation index decreases continuously from the first to the third map. This means that map organization is continuously tightening. The scale is from free floating points on map one to a single actual subgraph on map three. We also shall include in this class those maps whose F straightens out on the third map if the overall trend is clearly one of decrease.

2) The fragmentation index increases continuously from the first to the third map. This is the flip side of class 1 in every respect.

3) The fragmentation index increases from map one to two and then decreases from two to three. This means that map organization, initially tight, goes on to fragment, and then returns to a more integrated state. The scale is from AS to only P back to AS.

4) This is the flip side of class three in every respect.

5) In this class we shall consider those fragmentation indices which are straight lines, or very nearly straight lines. Increases or decreases are allowed only if they are small. The size of this allowance will be seen as we sort the maps. Theoretically a straight line could result no matter the level of organization of the map originally. Thus, it could consist at the outset entirely of points, and if the second and third maps had the same number of points, a straight fragmentation index would result. This is unlikely in practice for the following reason. If the number of points increases or decreases, the fragmentation index will go up or down. Reference to average element complexity will be necessary to ascertain what is really happening. However, if the initial map is a trailing or actual subgraph, and if subsequent maps are likewise, a straight fragmentation will result, although the number of lines and points within this subgraph may be changing violently. Thus growth in detail can result within an AS or TS while the fragmentation index remains stable. For this reason, Class 5 will likely additionally be characterized by very low NE and EC's.

Similar remarks about the behavior of the EC and the NE for each class may be made. Using the foregoing five classes allows us to sort any number of maps into a manageable number of classes.

In London only Baker and Bloch fall clearly in Class 1, that of increasing fragmentation. I add Mayo, Lincoln and Casyk to this class, even though their F's were close to constant from map one to two. Baker and Mayo were the closest of the pairs of kids on the trip, and were continuously closest to Miss Bloch. Furthermore, in all five cases there is an increase in the NE from map one to three and all the EC's hover in the vicinity of 5, or about on the order of an LTP. The general characteristics of this class are a median F which increases through the mapping sessions, a relatively stable EC, and an increase of the NE. In other words, the first map was relatively well integrated, perhaps as a result of the small number of elements utilized. Relatively contented with the initial effort, these mappers tended to add information to their initial effort, without really concerning themselves with integrating this new material into their initial schema. This is a mere sketch of a possible mapping strategy.

There are four entries in Class 2: Monroe, Cummings, Cruz and Nash. This class is further characterized by a lower EC, hovering between 4 and 5, and a steady decrease in the number of elements employed. The strategy employed by this class of mappers is simply the reverse of that used in Class 1. The first attempt at drawing a map is highly fragmented. Subsequent attempts at mapping are increasingly well integrated. In the case of Erica Cruz we have verbal confirmation of this
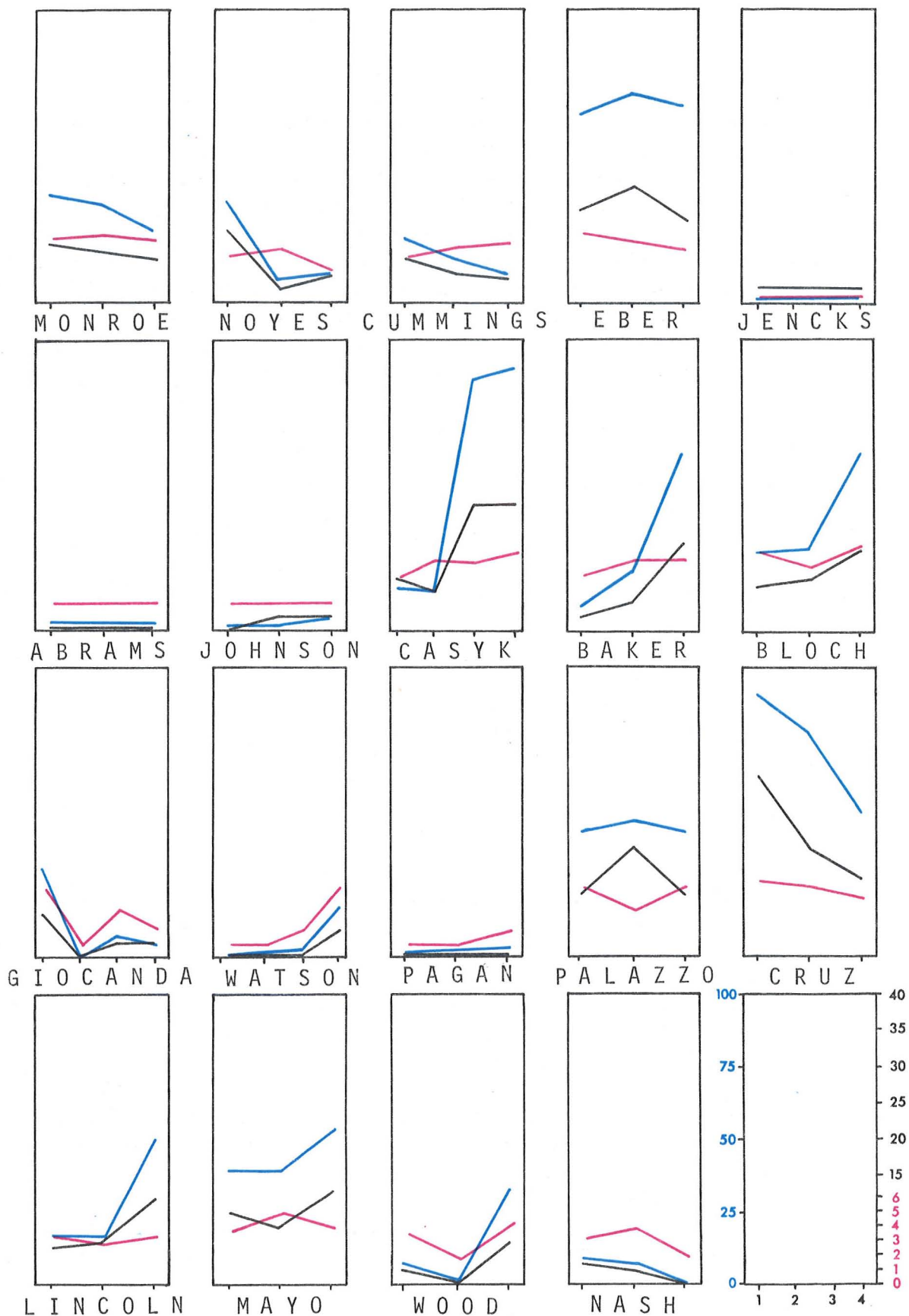
Figure 15.3   Fragmentation Index (blue), Number of Elements (black), and Average Element Complexity (red) for students completing at least three London maps.

strategy. She points out that in her initial attempt she loads her map with everything she recalls without regard to its integration. Figures 15.4 and 15.5 show her first and third London maps. True to her own assessment Figure 15.4 shows us almost all the items on the List of Places scattered over the map surface with beggarly attempts at integration. Cruz on her first London map shows us nothing more complex than two TS separated by the rest of the city. But how does she proceed? According to Erica, she starts dropping places on her second map (not reproduced) about which she is less certain, trying to increase integration among those places about which she feels some confidence. On her third London map she has reduced the number of places enormously, and has correspondingly increased the integration among the remaining elements. The map is now basically two trailing subgraphs, substantially elaborated from their initial appearance in London map one, separated by much less, cleaner space. (Some of the other startling properties of Erica's maps will be discussed later.) The tasks taken by the other mappers in this class are not identical. While they do not commence with the littering operation, they follow Erica in other respects, reducing elements, increasing their complexity in general, and gaining an increasingly integrated picture of London.

In classes 1 and 2 we see opposed approaches to dealing with the creation of a map of London. One starts in confidence and builds on that, resulting in increased fragmentation (Class 1). The other commences without confidence, then builds into increasing integration. The next two classes are combinations of these simplest situations.

In Class 3 we find only Eber and Palazzo. In both cases the F increases from map one to two and then decreases from map two to three, the NE follows an identical path, and there is a decrease in the EC from map one to two, although Eber's EC continues to decrease while Palazzo's returns to its original level. Generally the EC's are between 4 and 5 once again. This strategy may be characterized by a good start leading to over-confidence, followed by a return to caution. Notice that the F rises in response to the attempt to portray more things the second time around, and that the return to caution is accompanied by a decrease in the number of elements portrayed. Palazzo provides the perfect example of this type as her EC perfectly mirrors the rest of her efforts, while Eber's continuously drooping EC is less confirmatory, although it never drops all that far.

Class 4 is characterized by initial fragmentation followed by integration followed by a resurgence of fragmentation. The people included here are: Noyes, Giaconda, and Wood. Here the first attempt at mapping is not a great success, but the subsequent experience is
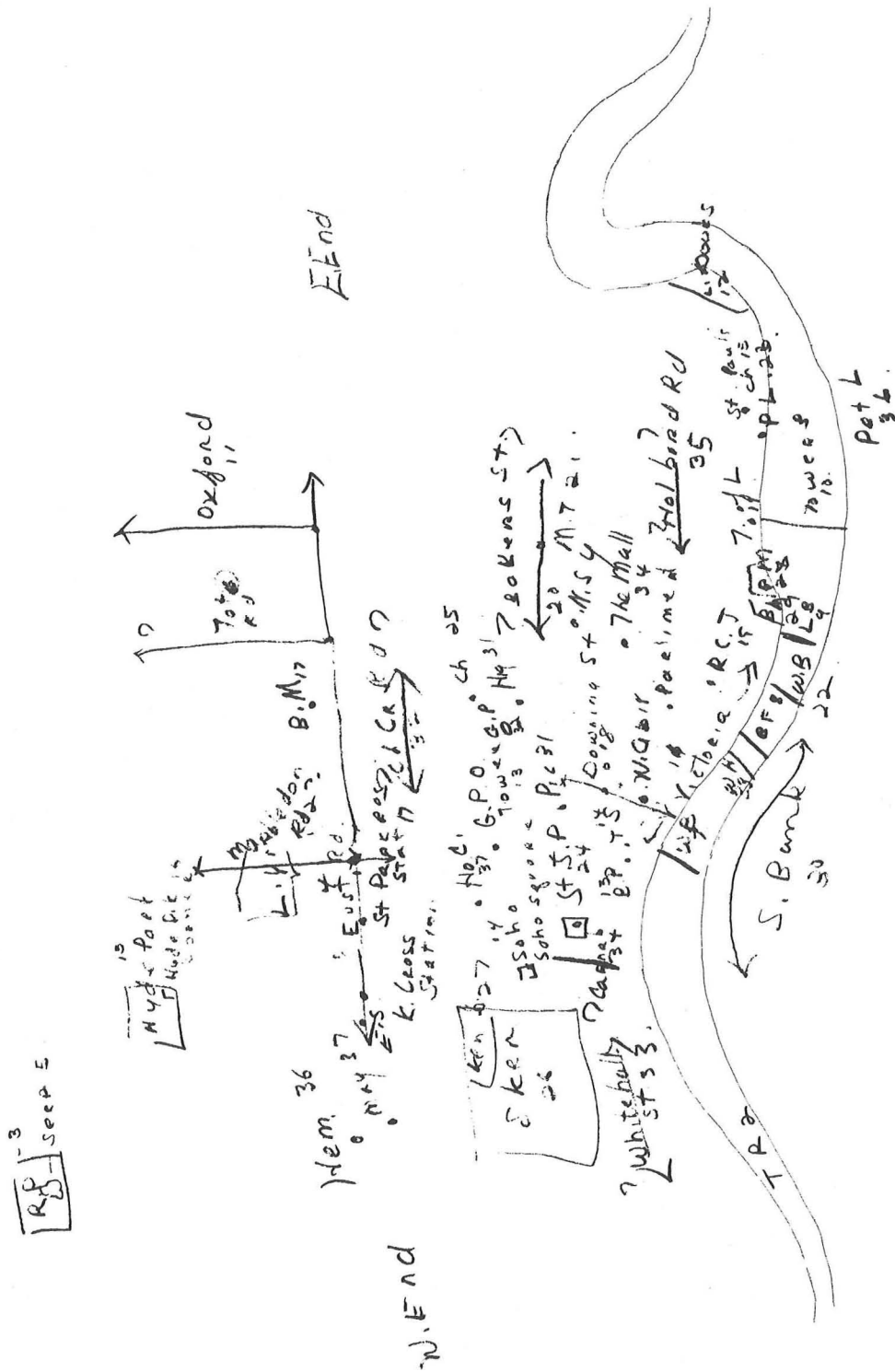
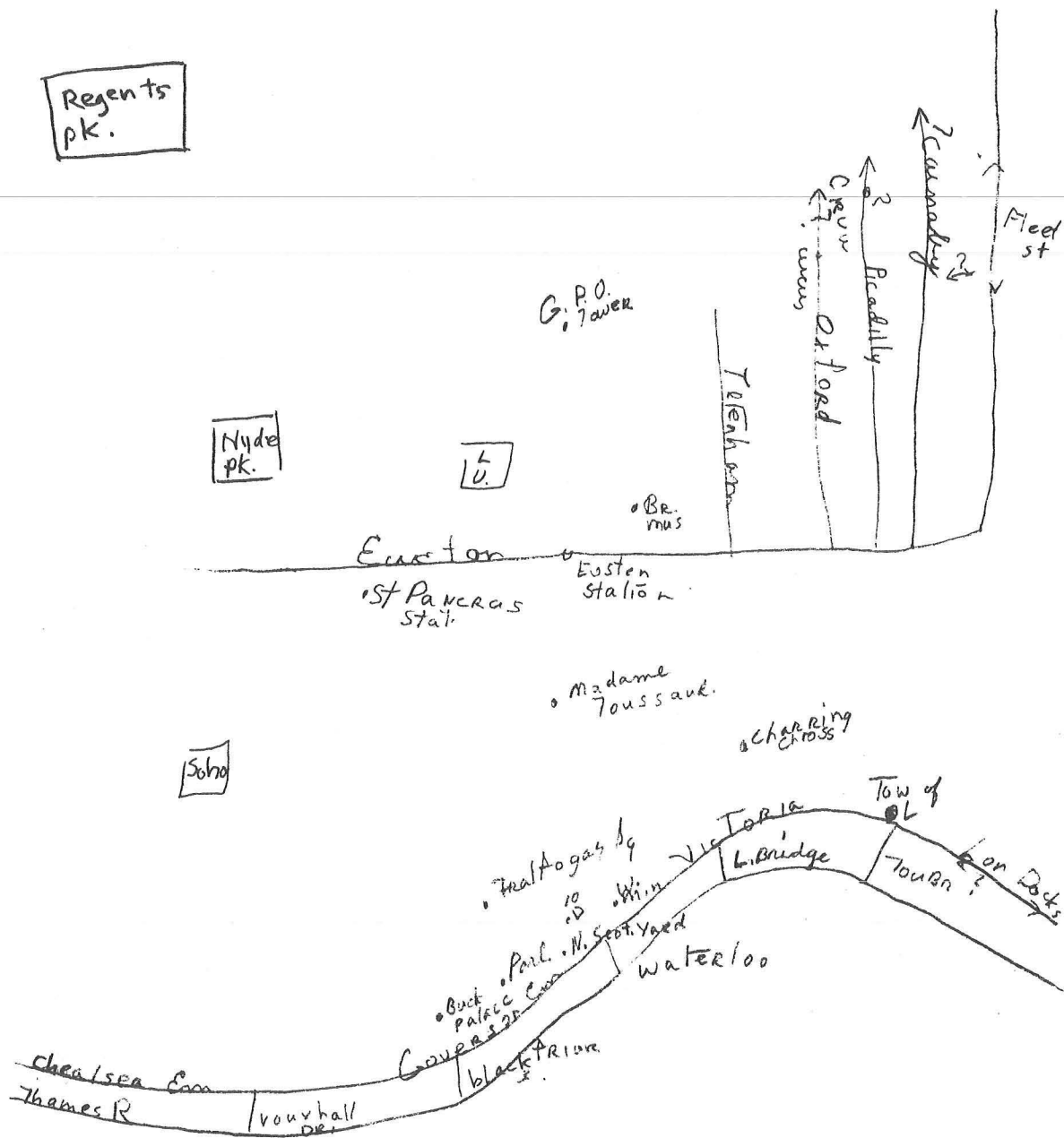465

Figure 15.4   First London map of Erica Cruz

Figure 15.5   Third London map of Erica Cruz

carefully integrated with the initial material in the second mapping attempt. Cheered by this success one becomes overconfident on the third attempt, including places insusceptible of integration. A fourth attempt should be characterized by increased integration, and such is the case for Marina Giaconda. Figures 15.6 and 15.7 show the first and third maps of Marina Giaconda. Before looking at these examine closely her graph. She starts out quite fragmented and then reduces her map to a single Actual Subgraph. That is, from the fragmented beginning seen in Figure 15.6 she proceeds to integrate entirely the pseudograph elements on her second map. But in neither of these two attempts has she gone so far afield as the Thames. Encouraged by the success of her first two attempts, she retains, on her third effort, all the integrated materials of the second but now reaches down to include the Thames (Figure 15.7). On her fourth map (not shown) she elaborates the Thames into a Trailing Subgraph and tries to establish connections between that and the rest of her map.

Figure 15.8 is a reproduction of my first London map. Generally speaking, my mapping attempts followed those outlined for Marina, my first map comprising a single rather trailing subgraph. On my second map (not illustrated) I was able to integrate much of the material on the first map, but on my third attempt (Figure 15.9) I used that integrated subgraph as a matrix within which to locate additional detail not susceptible of integration. Thus I have attempted to locate Covent Gardens (CG) but was unable to tie this into the rest of the network. The same is true of the Battersea Power Station (BPS), the British Petroleum Building (BP), the Courts of Law (LC) and St. Paul's (SP). It is quite likely that had I drawn a fourth map I could have reintegrated the map by tying these points in, but that on my fifth attempt I would probably have gone afield again. Marina is a perfect example of this class, with her oscillations typified by gradually decreasing amplitude.

The fifth class includes five kids: Jencks, Abrams, Johnson, Watson and Pagan. This class is characterized by stability in strategy. Jencks and Abrams show straight lines for all map measures, while Johnson and Pagan show nearly straight lines, and Watson shows straight lines for the first three, moving from an AS to a TS on session three and subsequently to increased fragmentation. Class 5 is characterized by more than stability, however. It is critically characterized by very low EC's, never rising above 2 except in the instance of Watson's fourth map. This is tantamount to saying that the stable mappers in terms of strategies were those who commenced mapping with the most highly integrated forms available. This is not a necessary attribute of stability. One could easily be fragmented all over the place and still be stable. None was, however. Stability walked hand in hand with integration.
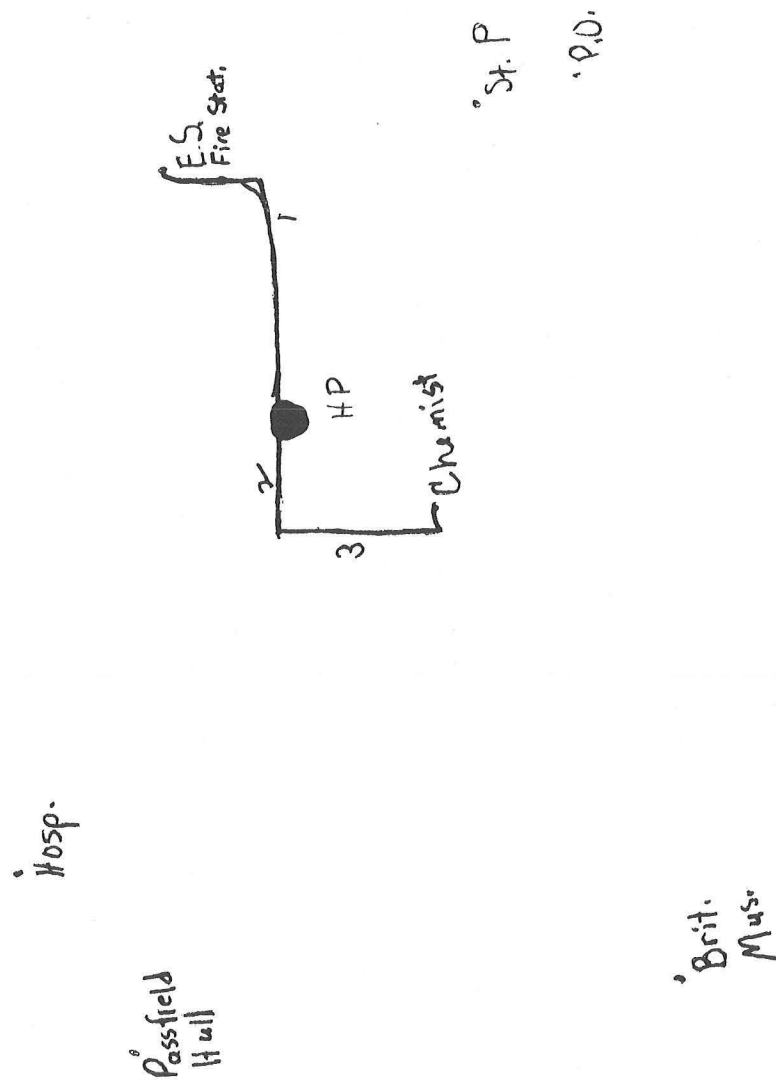
Figure 15.6   First London map of Marina Giaconda

N

Hospital

M. Tussauds

Passfield Hall

Euston. Sta.

Bio
Mus.

Mus.
Sg.

HP

School of Opth

St. Pancras
King's Cross
Barclays Bank

Reg. St.

?

Oxford St.
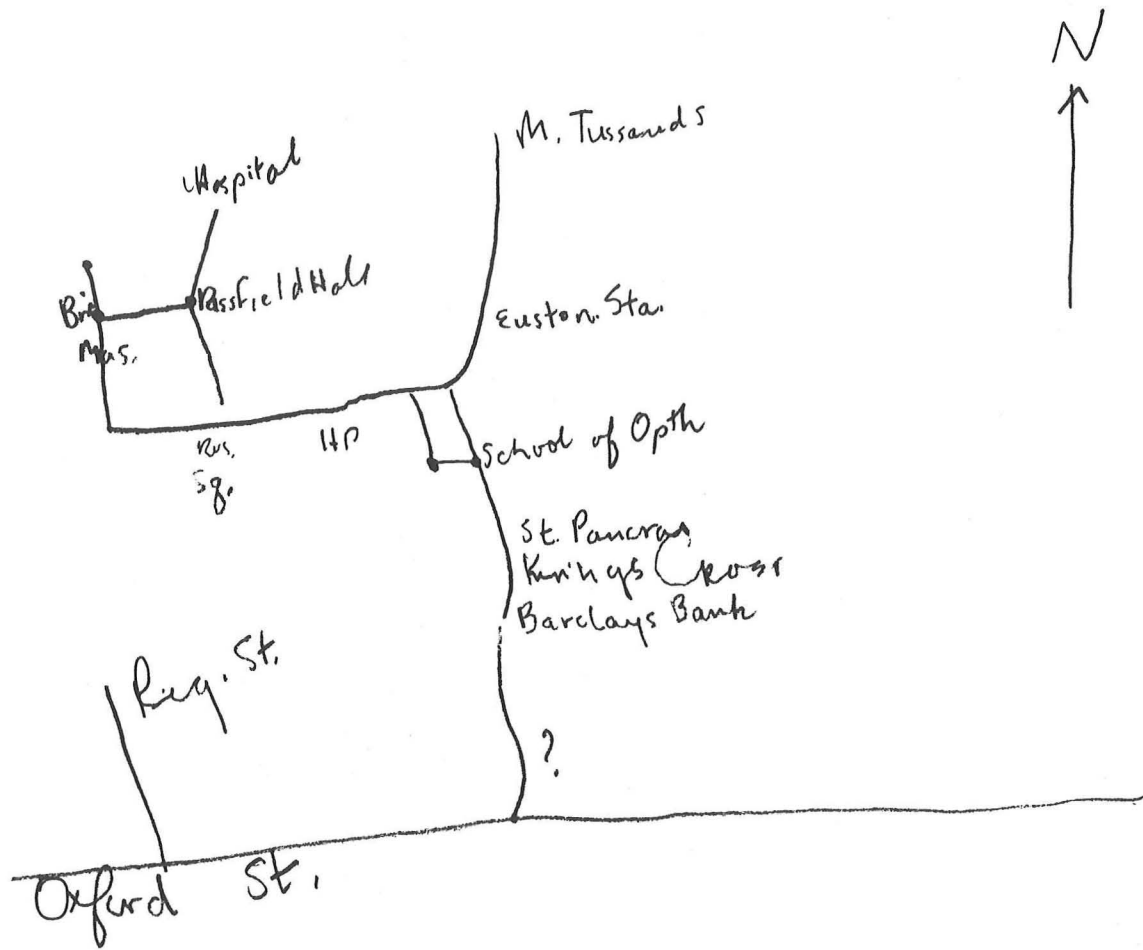
R. Thames

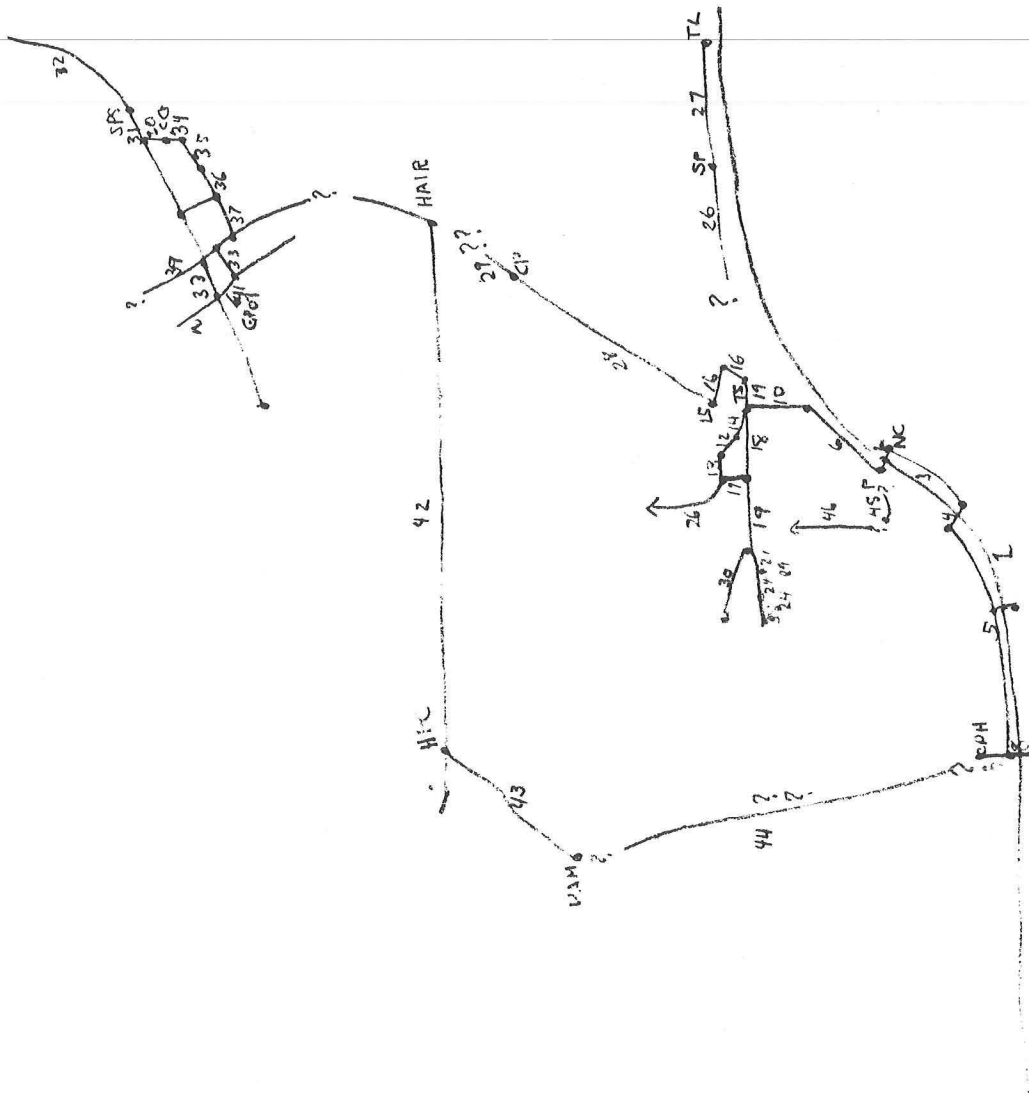Figure 15.7   Third London map of Marina Giaconda

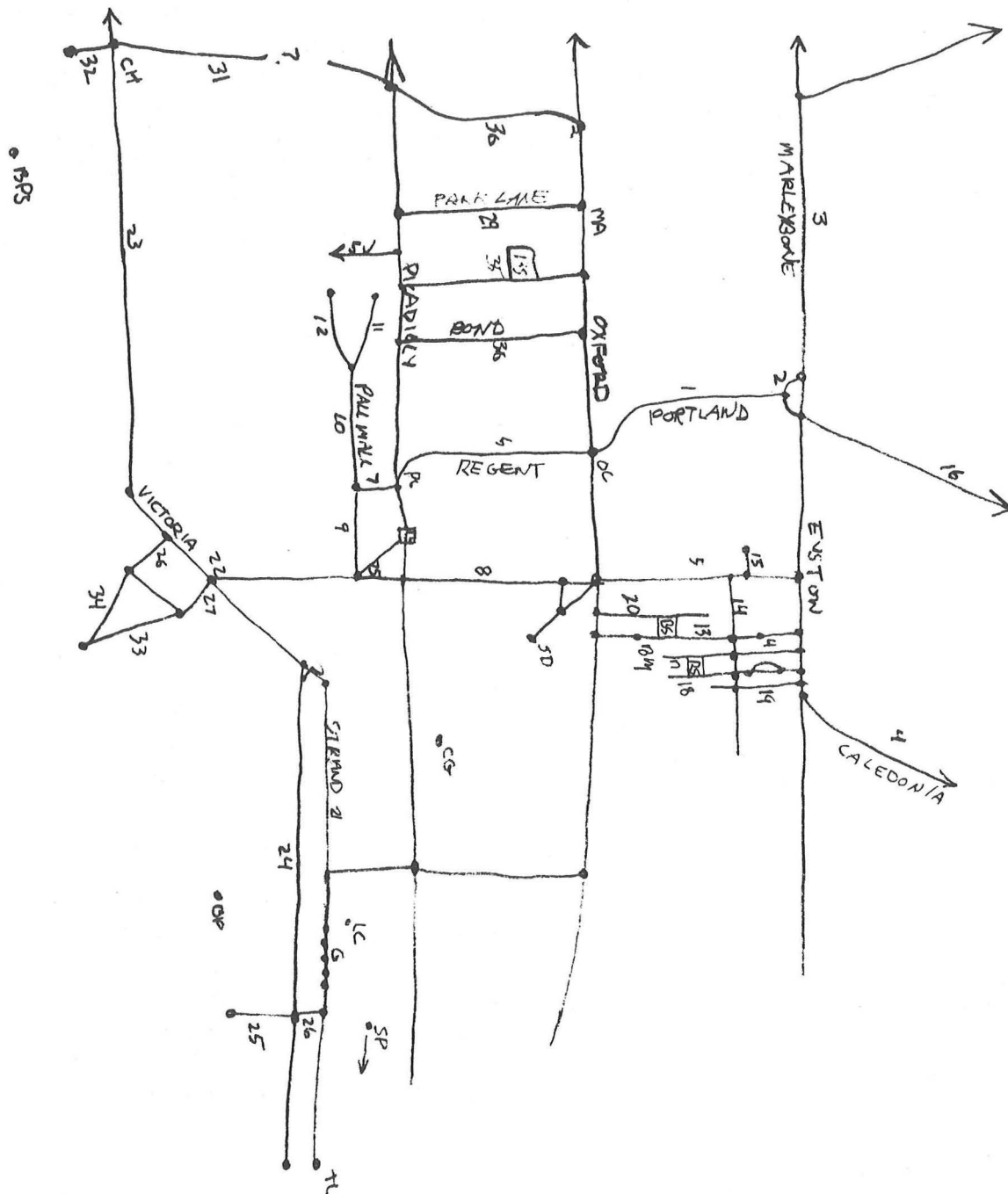Figure 15.8   Wood's first London map.

Figure 15.9   Third London map of Denis Wood

*   *   *

Figure 15.10 shows the pseudograph results individually for Rome. As a glance at the fragmentation index will show, the kids' mapping behavior in Rome was different from that in London. In the first place it was, after all, a different time and a different space. The London and Rome mapping sessions were separated by long days of experience. These days had brought changes in the kids and in the group as a whole. Nor can it be overlooked that on the day immediately prior to the first of the Rome mapping sessions I had gone over the kids' London maps with them individually. The differences between London and Rome can be briefly summarized:

1) The environment was different.

2) The individual kids were exhibiting changes in their personalities as they settled into the trip.

3) The group itself had changed, had become more solidified than it was in London.

4) Individual dispositions toward mapping had changed, this change being principally manifested in a greater eagerness to do "well."

This last issue was very visible and important. For example, several kids took notebooks with them on the all day sightseeing tour of Rome, and in these notebooks took notes of our route and in some cases made sketch maps. Two of these, reproduced as Figures 15.11 and 15.12, were drawn by Candy Fisher and Wanda Pierce. As these make clear, there was a great eagerness that had behavioral consequences. Another consequence was the rush to buy maps of Rome. Most of the kids had purchased such maps before the sightseeing tour had been on the road two hours. These maps had an interesting peculiarity in that they were printed with south at the top. This freak showed up that night in the mapping session where many maps were drawn with north and south flipped—unknowingly. This was later pointed out, but the image had in some minds become fixed, leading to disasterous confusions about the nature of Rome's spatial layout. What is critical is that the kids were ready and willing to map, and excited about the possibilities of doing it all right.

Given these changes in the physical and social environment, in the kids' personalities and in their motivation to map, it is to be expected (and hoped) that the kids would change pseudograph class in Rome.

It is the nature of the changes that is instructive.

Class 1. Susan Lincoln, Candy Fisher, Phylis Gordon and Bob Watson were the Class 1 mappers in Rome, and of these only Lincoln is a pure case, with initial confidence leading to the attempt to locate places whose relative location was not well known. A strong case could actually be made for including Fisher in Class 5, except for the fact that she has an abnormally high increase in fragmentation on the third map, and an EC that is entirely out of line, if not with the theoretical definition of Class 5, then with all the examples of Class 5 that we have seen.

Bob Watson likewise could be placed in Class 5, and with far greater justification than Fisher. His case is rather special and demands attention, for Bob had spent several days in Rome during the previous summer. He knew the city well. I observed Bob drawing his first map of Rome and we discussed it. Figure 15.13 shows this map and, as can be seen, Bob did not follow the point-line-area method at all. It is a distinctive product for Group L, with its lack of emphasis on lines and in its pictoral quality. His third Rome map is similar, simply including more points and even less lines (Figure 15.14). Increasing fragmentation in this case simply means more points. Bearing this out is the very slight increase in the EC. In other words, this is just such a case of being misled by the fragmentation index as was described in the introductory notes. If Class 5 were simply to describe invincible stability of purpose, Watson would belong there.

In Class 2 we have Cruz, Mayo, Eber, Giaconda and Pierce. Cruz is still pursuing her method of scatter and subtract that she used to such purpose in London. Erica represents another kind of stability, the kind that transcends the mapping of a single city. She may not approach the second map of a city the same way she approaches the first, but she approaches each city in the same manner. Wanda Pierce, in the pseudograph analysis for the first time, used her initial pre-mapping sketch to good purpose, and reduced the chaos of Rome to a single AS by the third map. Mayo, obviously worried by what she herself perceived as increasing fragmentation in the London maps has switched strategies to improve her product in Rome, and once again to good effect, for she too reduces the chaos of Rome to a single AS by the third map. Marina Giaconda, abandoning her oscillatory ways, began her mapping of Rome with practically no connections whatsoever and increased these with such vigor as to bring Rome to a single TS by the third map. Nor is Janine Eber playing a significantly different game: oscillation turns to fragmentation in an attempt to cram the map surface
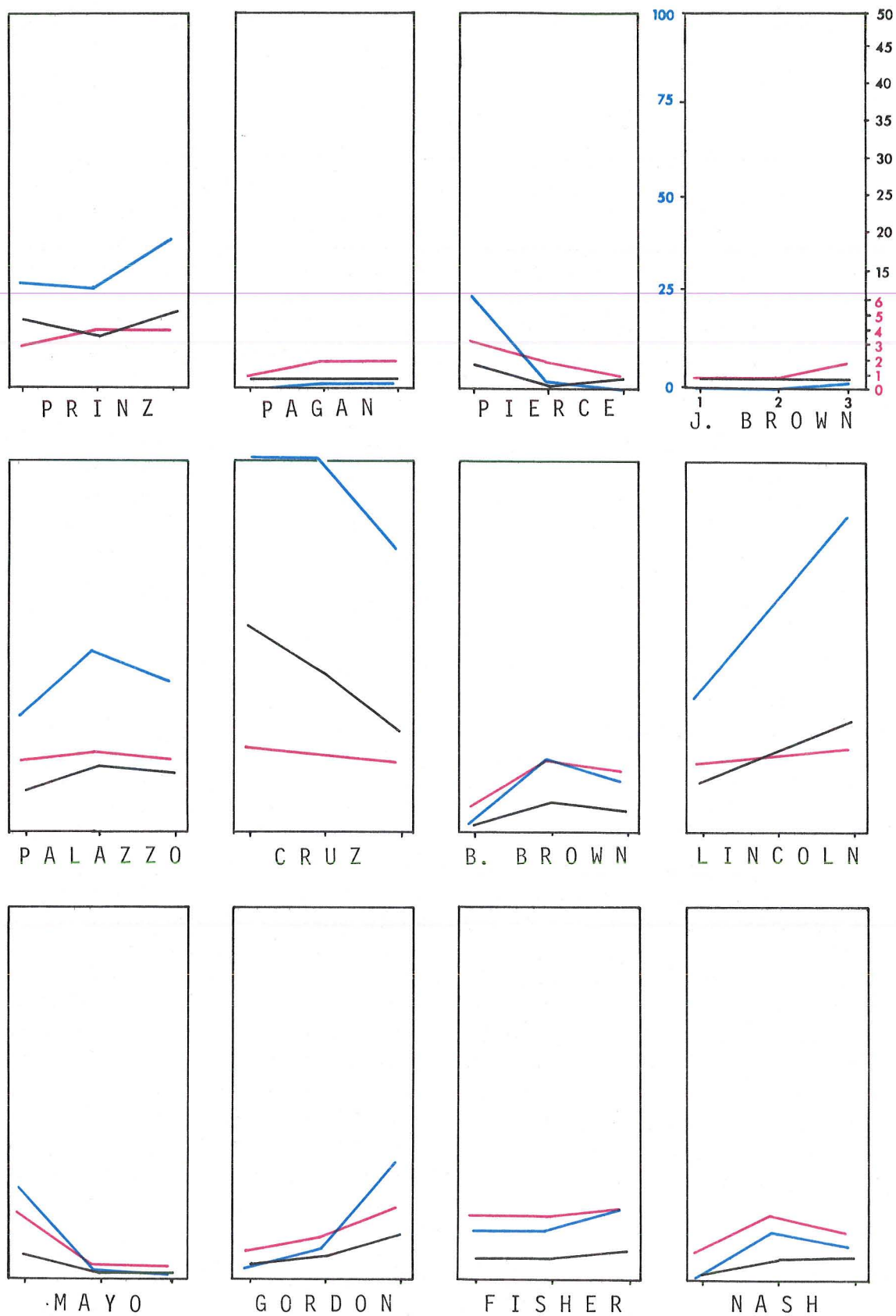
Figure 15.10   Fragmentation Index (blue), Number of Elements (black), and Average Element Complexity (red) for students completing at least three Rome maps.

Row 1: CUMMINGS, HENDRICKS, ABRAMS, (axis with scales: 100, 75, 50, 25, 0 in blue; 50, 45, 40, 35, 30, 25, 20, 15, 10, 5, 0 on right; 6, 5, 4, 3, 2, 1, 0 in red; x-axis 1, 2, 3, 4)

Row 2: EBER, JENCKS, CASYK, MONTAIGNE

Row 3: BLOCH, GIOCANDA, WATSON, SEWARD
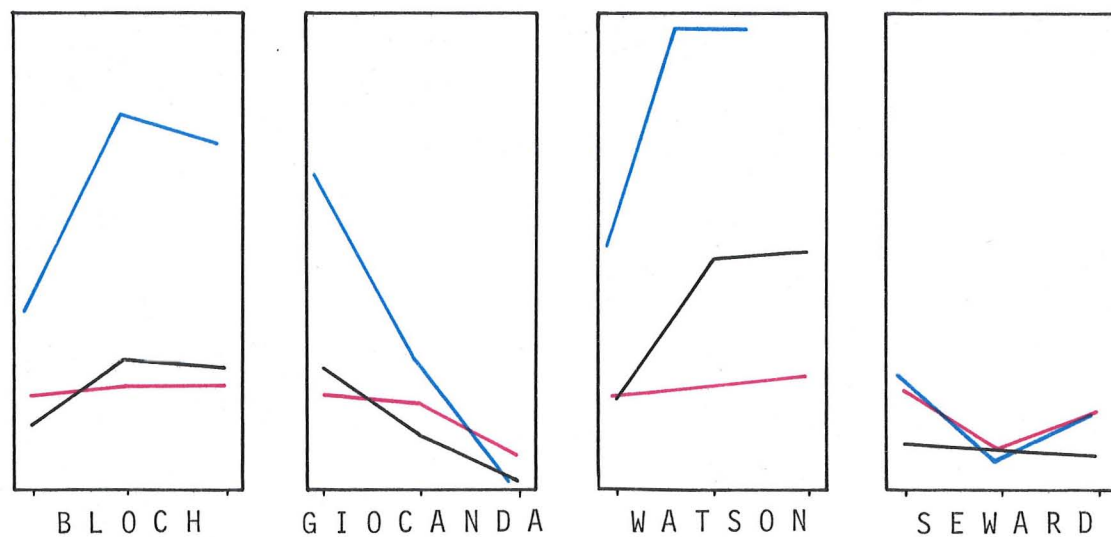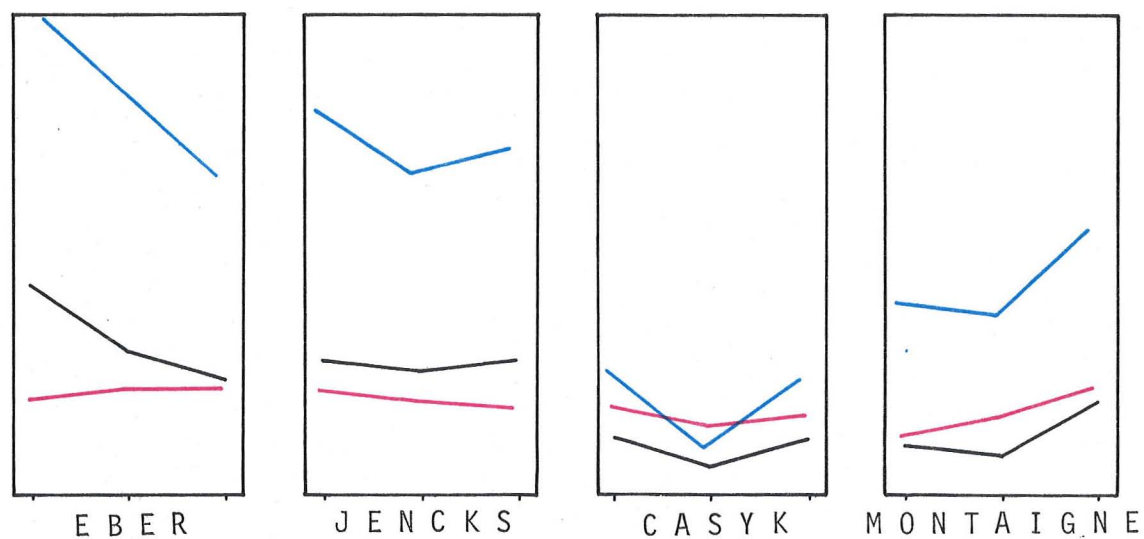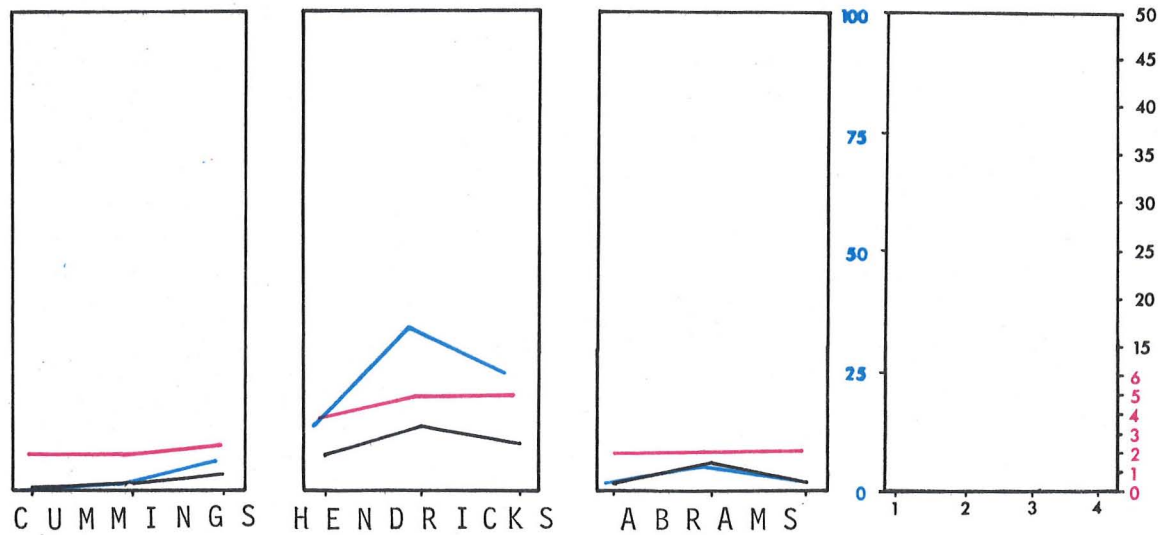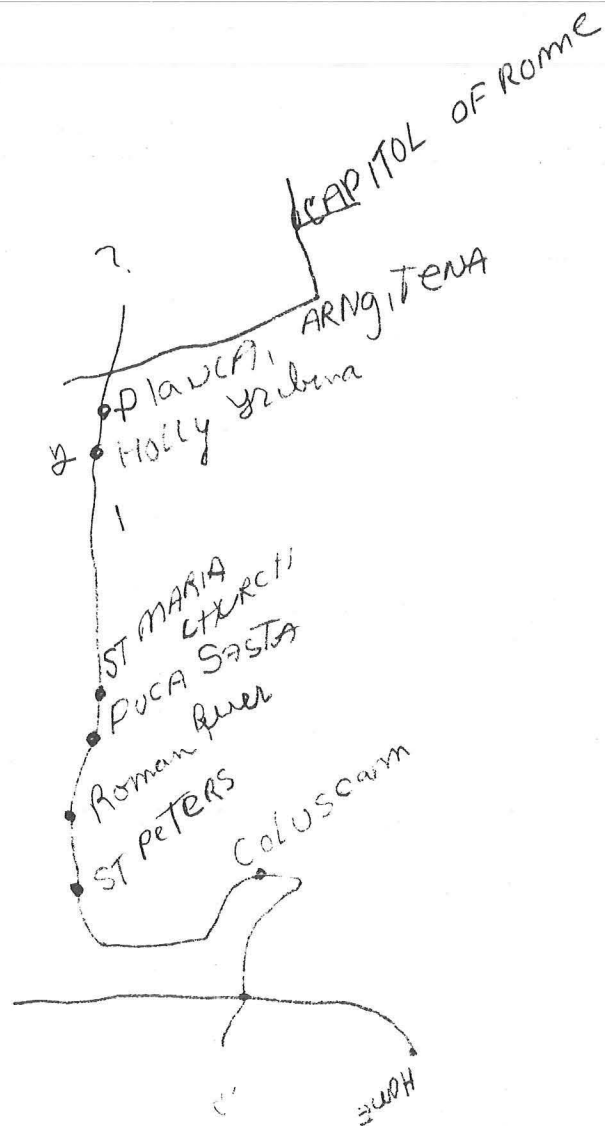
Figure 15.11   Pre-map sketch of Rome by Candy Fisher
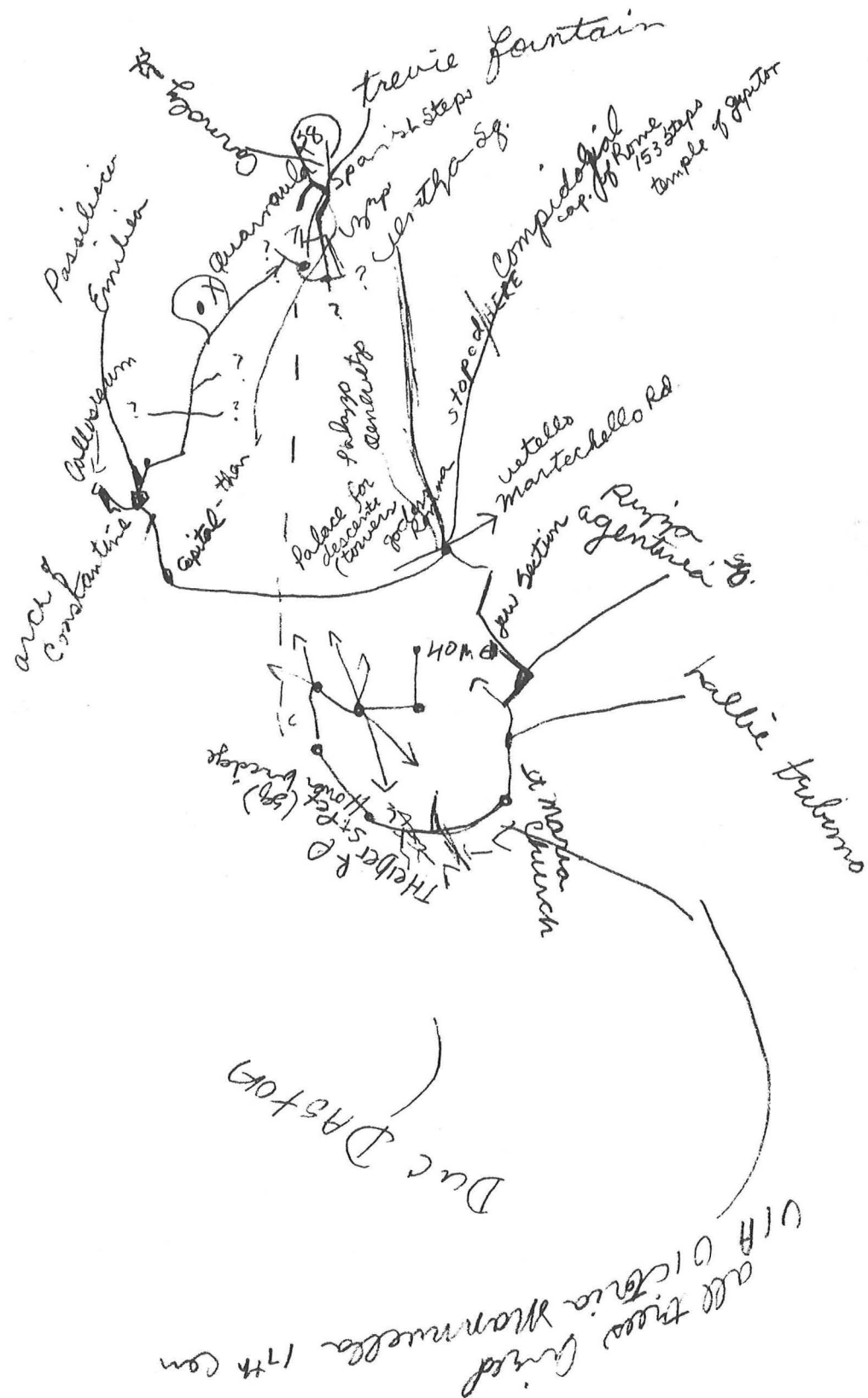
Figure 15.12   Pre-map sketch of Rome by Wanda Pierce

Olympic Stadium N

Castello Saint Angelo or Hadrian Tomb

Vatican Gardens

Sistine Chapel

Cleopatras Needle

Saint Peters

Ponte Vittorio Emanuelle

W VATICAN

Spanish Steps

Barberini Fountain

Barberini Hotel

Barberini

Trevi Fountain

E

Big Train Station

Tiber River

(Capitoline Hill)
Vittorio Emmanuele

Colloseum

Roman Forum

Villa (?)

S

Figure 15.13   First map of Rome by Bob Watson.

Figure 15.14 Third Rome map of Bob Watson

with Roman detail. So rich has her surface become that she is never able to bring it to total control, though both her NE and F fall somewhat to the third map from their Olympian heights. This class threw caution to the winds in the first Rome map hoping for a payoff in richness and detail, and then scrambled in the following map sessions to impart order and connectivity to the space of Rome.

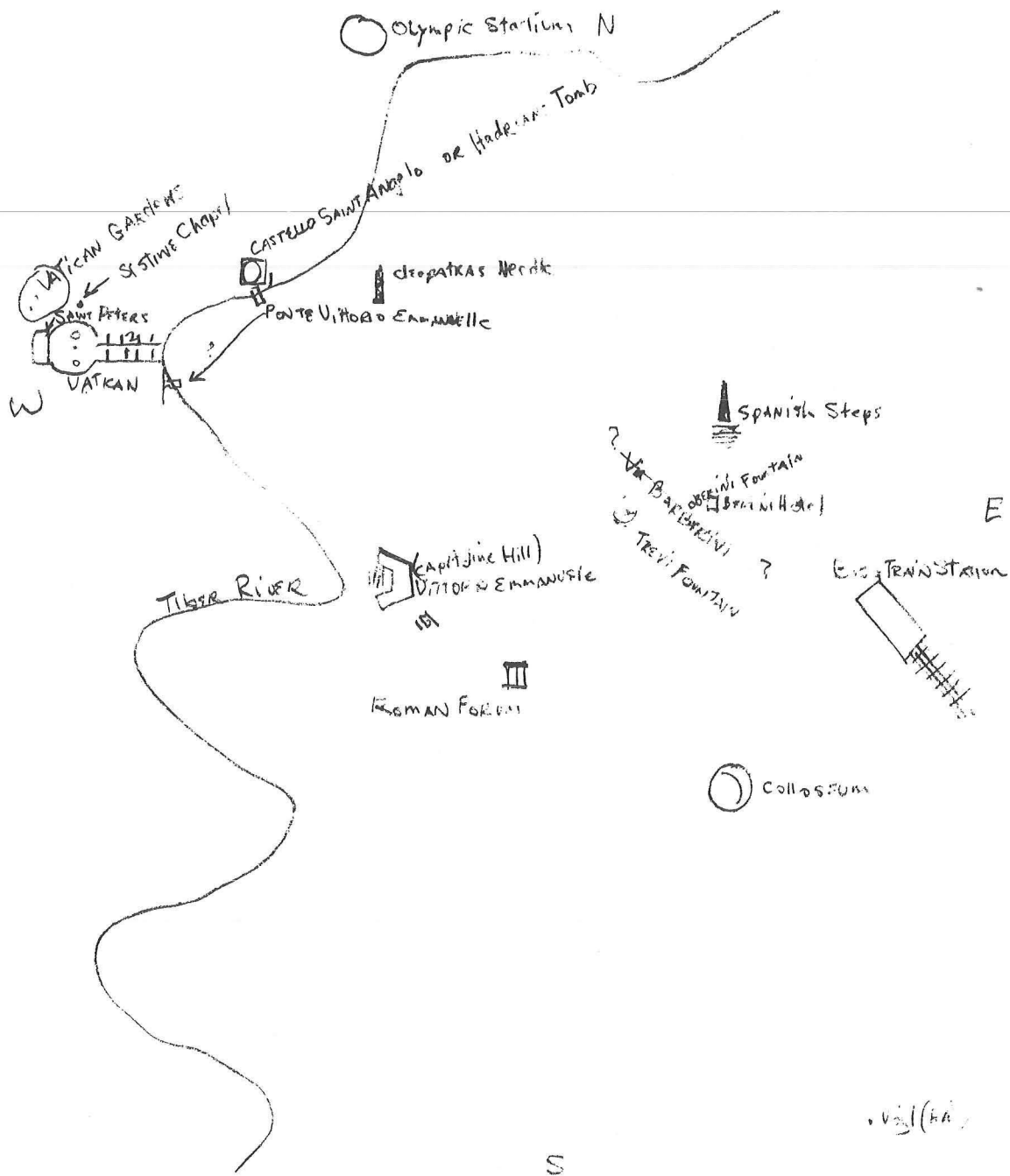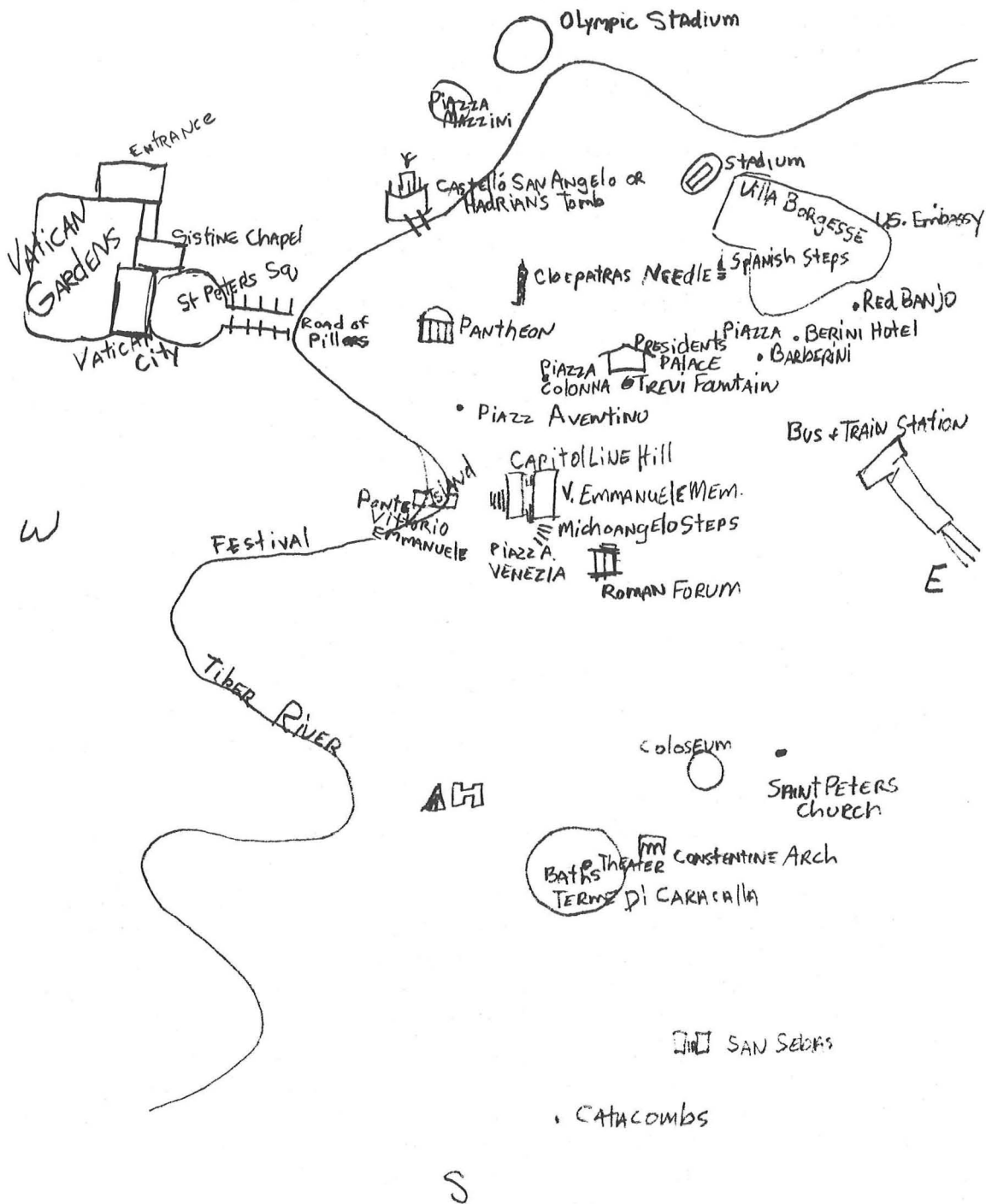In Class 3 we find Hendricks, Brown, Palazzo, Bloch, and Nash. Hendricks and Brown appear for the first time in the pseudograph analysis, drawing three maps in Rome in response to the general increase in motivation described above. Bloch and Nash have graduated to Class 3 after having been in Classes 1 and 2 respectively. Nash's performance in Rome is only slightly different from London, though the trends are distinctive as can be seen in his NE. Bloch continued on her road of increasing fragmentation that she had commenced in London until her F hit the vicinity of 80, at which point she began a retreat. She also caught the motivation high and was intensely interested in the Rome mapping sessions. Palazzo was a Class 3 mapper in both cities, and like Cruz exhibits transenvironmental stability.

Class 4 mappers included Jencks, Casyk, Prinz, Montaigne and Seward. These last three appear in the pseudograph analysis for the first time, victims of the heightened motivation that infected the group. Jencks' switched from Class 5 in London to Class 4 in Rome which was the most violent of all the shifts that took place. He went from F's in London of 1 to Rome F's running between 72 and 80. This is an artifact of Jencks' misconstruction of the Environmental A mapping instructions in London which he believed asked him to arbitrarily connect all located points. When this was cleared up, Jencks' map turned out to be highly fragmented. Furthermore, while the motivation of others was up, his was down, as indicated by his set of remarks made to me in Innsbruck (see Chapter 9), and his inability to occupy his position of group power prior to the Play (see Chapter 10). Prinz's appearance in Rome also warrants attention. Karl, in company with Porter Portman, made a great show in London of mapping expertise. He had learned topographic field mapping with the Scouts, while Porter was, of course, fully acquainted with Army mapping techniques. Both viewed our simple point-line-area method with immense scorn and no little pity—until they tried to draw a map of London. Both were relative failures, but ashamed, then agreed on the trip into Rome to give it another try. Porter's was again dismal failure, but Karl came through and continued to draw maps. He proved to have tenacity but little mapping talent and followed the Class 4 route to ultimate success. Seward, Montaigne and Casyk are archtypal Class 4 mappers in Rome.

Class 5 had four members: Abrams, Pagan, Cummings and Jane Brown. Abrams and Pagan are holdovers from London, and join Cruz and Palazzo in transenvironmental stability though neither of them were as stable within Rome as they had been within London. Finding Tracy Cummings in Class 5 is no surprise, since in London, following the Class 2 route, she had managed to bring her map to a single subgraph in the end. She simply retained that subgraph organization to handle her knowledge of Rome. Jane Brown's appearance in Class 5 here is similar to Des Jencks' Class 5 appearance in London, although Jane's connections were withal less arbitrary. Rome was her only serious fling with the maps and she followed the mapping instructions to a T, naturally resulting in a single subgraph.

The Rome sessions revealed a higher order of mapping stability, that of transenvironmental stability. At least four kids indicated this sort of stability, Cruz, Abrams, Palazzo and Pagan. That is, they followed in Rome the identical strategy that they followed in London. It is quite possible that someone like Leslie Casyk could also join this group, not by virtue of any similarity in her approach to any two maps, but because her approach to each map is unique. She may be searching during her first seven maps for an approach that will carry her through the rest of the series. Her variations may be similarities in this sense. However, the maps provide no information on this point, and so variations must remain variations. This question of transenvironmental stability does, however, raise two points:

1) That the series of maps produced by a given kid must be examined in a continuous context across environments and through time to provide information about personal mapping strategies and styles.

2) That each additional map in this series is capable of causing enhanced analytic difficulty. Thus, it would be very simple to examine a single map produced by a kid and type it, and then announce to the panting public the discovery of TYPES of mappers. This has been done. However, on another map, a given kid may become another type. Then the problem of classification becomes more complex, more difficult, because organic and dynamic. This is the problem we face, and which the pseudograph analysis was designed to deal with.

*   *   *

There are only eight kids who completed at least three maps of Paris. These were three motivational classes in Paris: those not about to do the maps, those fervently eager to do the maps, and those who didn't care but who could be persuaded. Obviously, the eight mappers

here considered fell in the latter two classes. None of these eight fell into pseudograph Classes 1 or 2, so our discussion will commence with Class 3 (see Figure 15.15).

Eber, Monroe, Casyk, Palazzo and Gordon fell in Class 3. Palazzo completes her transenvironmental stability series by being in Class 3, for the third time; and while Eber was a Class 2 mapper in Rome, she had been a Class 3 mapper in London, so that this is not her first appearance in this class. If Palazzo is a text-book case of a Class 3 mapper, and Eber is slightly overdone, Monroe is even more so, her fragmentation index running way off the graph on the second Paris map. Gordon is like Palazzo, a text-book case. Casyk illustrates a Class 3 mapper who has gone on to a fourth map and her fragmentation index lends support to our hypothetical sketch of the continued behavior of a mapper in this class.

There was only one Class 4 mapper in Paris: Marina Giaconda, and she is an excellent example, starting off fairly fragmented, only to rebound into enhanced fragmentation as she continues to amass knowledge of Paris. Pagan and Abrams fill Class 5 in Paris and complete their own transenvironmental series, having remained in this Class from their first appearance in London.

<p style="text-align:center">*   *   *</p>

Below we have listed all of the kids that drew at least three maps of any city, and beside them we have listed the pseudograph class into which each fell in a given city. It is quite possible that you have assigned a given kid to a class other than that to which I have assigned him according to your interpretation of the data. In this case, I suggest that you make appropriate changes on Table 15.0.

<div style="text-align:center">

TABLE 15.0

KIDS RANKED ACCORDING TO MAP STRATEGIES

</div>

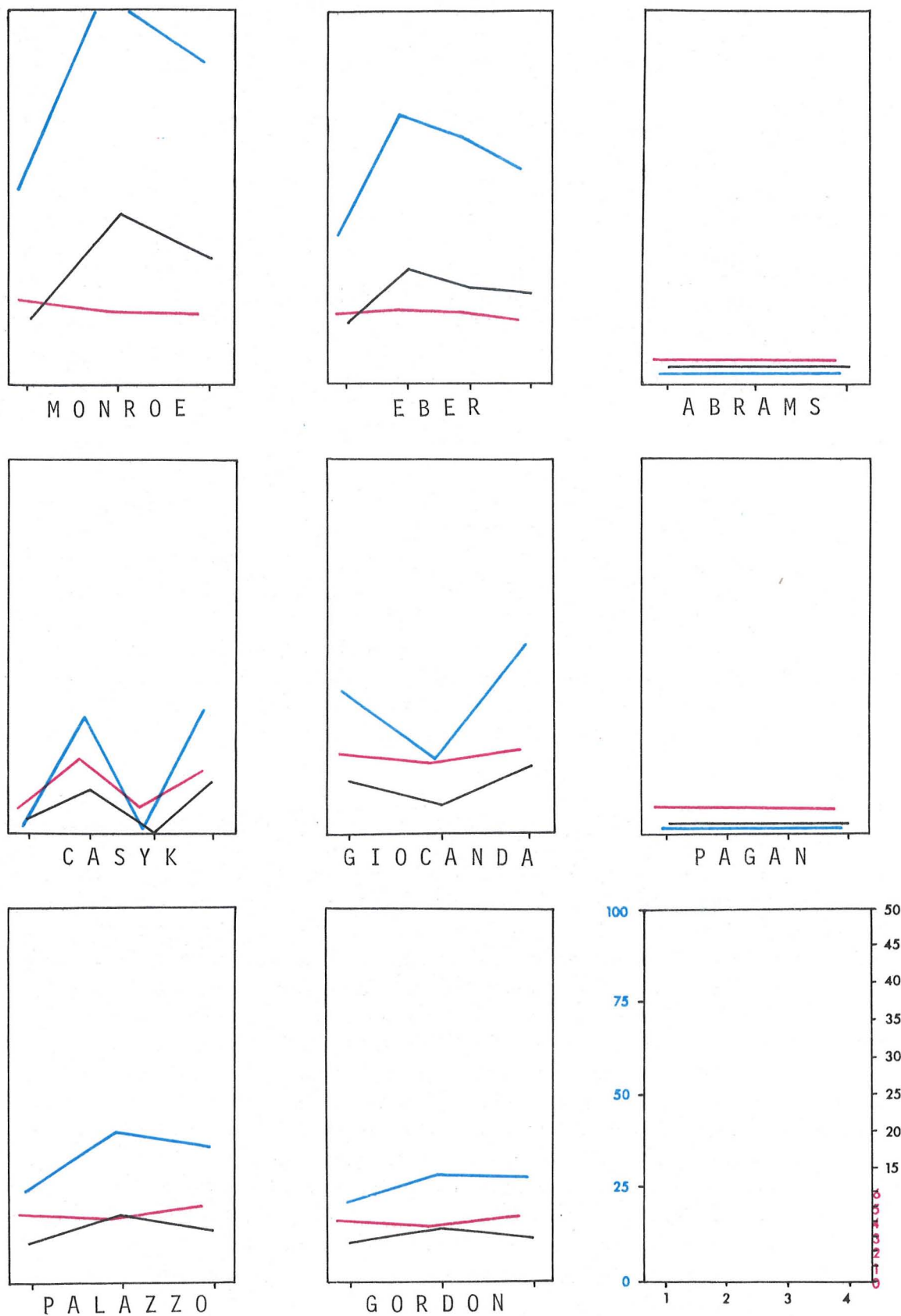|	London	Paris	Rome
Candy Fisher			1
Betty Baker	1		
Susan Lincoln	1		1
Claire Mayo	1		2
Phylis Gordon		1	3
Leslie Casyk	1	3	4
Wanda Pierce			2
Erica Cruz	2		2

Figure 15.15   Fragmentation Index (blue), Number of Elements (black),
and Average Element Complexity (red) for students com-
pleting at least three Paris maps.

Taylor Nash	2		3
Lana Monroe	2		3
Tracy Cummings	2		5
Ann Hendricks			3
Bill Brown			3
Janine Eber	3	3	2
Vittoria Palazzo	3	3	3
Marina Giaconda	4	4	2
Rhoda Noyes	4		
Therese Montaigne			4
Karl Prinz			4
Bobbi Seward			4
Jane Brown			5
Laura Johnson	5		
Bob Watson			1
Desmond Jencks	5		4
Nybia Pagan	5	5	5
David Abrams	5	5	5

There are two possible justifications for the creation of a table like this: 1) that the mapping strategies bear genetic relationships to each other; and 2) that mapping strategies bear some interesting relationship to some aspect of the personality or behavior of the individual kids. Both points will be made.

1) The mapping strategies do bear genetic relationships to each other. Class 1 and Class 2 are genetically prior mapping strategies, and in the end are integrated into higher types. Thus Class 3 shows increasing integration (Class 2) in alternation with increasing fragmentation (Class 1), while Class 4 shows the opposite combination of Classes 1 and 2. Class 1 is not a successful strategy since it leads to less and less useful products. Of the five people who commence in Class 1 and continue mapping (Miss Bloch is the fifth—not included on the table), four of them move to higher order classes. Only Susan Lincoln follows this strategy in more than one city. Furthermore there is only one case of a reversion from a higher class to Class 1, and that is the special case of Bob Watson which has been discounted above. The evidence is fragile but clearly points in one direction: having once created a series of maps that become increasingly disconnected, the kids did not repeat the process. Thus the process is prior for people who use it once. It is prior in another sense as well: all of our maps exist at some point in their construction in this state of fragmentation, increasing from second to second, as points are added to the surface faster than they can be connected.

Class 2 is the basic connecting strategy, and yet by itself is as undesirable as Class 1 in that it postulates a highly fragmented first map, or a useless beginning. Of the four kids commencing with this strategy and continuing to map, three of them move up to higher order strategies in subsequent cities. Furthermore, there are only two reversions to this type: Marina Giaconda and Janine Eber, in Rome. (Note that all three instances of reversion to Classes 1 and 2 occur in Rome.) The evidence is no more substantial here than it was for Class 1 and yet the tendency is clear: once this strategy has been tried, it has been abandoned. Clearly, this strategy is subsequent to Class 1, for until there is scattered, pointilistic, instantaneous knowledge and experience, there can be nothing to integrate.

A Class 1 mapper approaches an environment with preconceived notions about its layout and reality and allows his mind to be blown by experience—along with his map. The Class 2 mapper approaches the environment with a tabula rasa and allows experiences to crowd in, to be sorted out and integrated with continued experience. Class 3 and 4 mappers approach an environment neither in so blank nor so organized a fashion. The hallmark of both strategies is the ability to integrate or fragment as experience and the environment demand. Class 3 tied for most popular Class, contained one transenvironmentalist (Palazzo), as well as one who used the strategy in London and Paris (Eber). This strategy allows you to approach a city with some integrating image in mind that holds it all together for the first map. Then you have a framework on which to load detail of uncertain location. A Class 1 mapper at this point would continue to add detail and still more detail, but the Class 3 mapper cries "Whoa!" and reintegrates, to provide a viable framework for the next assault of the senses. And so on. Leslie Casyk in Paris shows us what four maps in this strategy would look like. Class 4 is the opposite side of the coin. Experience precedes image for this Class mapper, but an integrated image always follows the initial harvest of pointilistic information. And then this image provides a base for further garnering. The two classes are very similar and very popular. More kids used these two classes than 1 and 2 put together and certainly many more than Class 5. This is as it should be, for most of the kids were trying to come to grips with the mapping problem. Naturally they adopted the most flexible and efficient strategies, those allowing for continual experimentation, and those which, at the same time, admit of frequent, alternating integrated success.

Class 5 is the classy class and as is always the case with class it has its drawbacks along with its elan. It was as popular a strategy as Class 3 and contained two of the three transenvironmentalists:

Pagan and Abrams. It should not be surprising that the most stable intracity strategy was also the most stable intercity strategy. However, Class 5 allows of no experimentation. You either have it or you find yourself in another class. Of those commencing in a lower class only one, Tracy Cummings, jumps up to Class 5. As we pointed out earlier, a Class 5 mapper's first map is generally an actual subgraph (never less than a trailing subgraph). There is a subtle reason for this and it involves the advantages and drawbacks of this stragety. To draw a complete actual subgraph first time out means something. In the case of all but one of those drawing Class 5 maps in London it meant that they had to ignore much of their experience. Only Pagan dared to include the Thames. There was simply no way for these kids to include everything that they saw, and still connect it all up. So they didn't. The very opposite of Erica Cruz who included it all at the beginning. Class 5 mappers include only those parts of the city that they have mentally integrated. On following maps the Thames appears on the third map of Jencks and Watson, and never appears on the maps of Abrams and Johnson. To have included the Thames earlier would have meant fragmentation, experimentation. These mappers do not go beyond the known. But if Class 5 does not include experimentation, it uniquely allows growth. Class 5 maps grow one to the other before your eyes like animation stills. The maps of David Abrams are the outstanding example. He maps in each session only those things he can integrate and consequently his map seems to grow organically, larger like a body. Other class maps grow too: grow more detailed or less detailed or more linear—but always within an established frame of space. David starts out around home, and then moves out from there to encompass increasingly large areas, all neatly and veridically connected. This strategy provides the greatest likelihood of turning out useful products at each stage of the mapping process, but demands a well-worked out and highly formalized approach to mapping. It means that that waffling integration-fragmentation has been accomplished in mapping work elsewhere or overcome as the result of some characterological trait. For Class 5 mappers, not only is the map integrated but the mapping operation is integrated and has been integrated personally.

To summarize: Classes 1 and 2 are unsatisfying, genetically prior mapping strategies, 1. because it commences with an image that procedes to disintegrate, 2. because it starts with disintegration. Both strategies result in the minimal number of satisfying, useful products. Classes 3 and 4 are both flexible and frequently satisfying, and integrate the two lower orders allowing the naive mapper to work on an approach to mapping that will work. Class 5 results consistently in the best maps, is the most efficient, but is absolutely inflexible, demanding a stable strategy worked out prior to actual mapping. A mapper moves from Class 1 or 2

or both, to Class 3 or 4, and finally ends up in Class 5. Learning to map is like learning any other language.

2) Mapping strageies are related to other personality traits. The argument needed here lacks certain critical pieces of evidence. These are to be found in Chapter 19. There it is shown that mapping strategies relate to seat location on the bus, to number of seats occupied during the tour, and to the number of kids sat next to during the tour. Briefly, the higher the class of mapping strategy, the more mobile the seat behavior and the more likely the kid is to sit in the middle of the bus; the lower the class of mapping strategy, the less mobile the seat behavior, and the more likely the kid is to sit in the front of the bus. The median case is too complicated to present here.

But without this corrolary information there are certain remarks that we can make. Certainly Figure 15.0 is impressive evidence that there is something in the kids that relate to their use of mapping strategies. To interpret this table let us try to argue that it shows that mapping strategies are related more to variations from city to city rather than kid to kid. In the first place we might expect to see that a given strategy was more likely to be used in a given city. But this is not what we find on Table 15.0. There is no significant variation in the numbers of kids employing a given strategy for London and Rome. The variations existing between Rome and Paris can be explained, not on environmental grounds, but on genetic strategic grounds. This is not to say that the environment exerts no influence, but rather that it cannot explain the choice of mapping strategy.

Another argument that could be advanced to explain the choice of mapping strategies would be that of motivation and learning. Certainly motivation and education played important roles in the project. However, while motivation can explain the increase in the number of mappers drawing at least three maps in Rome, neither motivation, nor education can explain the lack of systematic variation between the choice of Rome and London strategies. Furthermore, motivation and education can be advanced as still other parts of the explanation for the lack of Class 1 and 2 mappers in Paris. That is, motivation and education can explain the variation in numbers of mappers far more readily than it can explain the choice of strategies per se. This is not to say that motivation and education play no role in moving a mapper out of Classes 1 and 2, but rather that this role is circumscribed. Furthermore, motivation (and likely learning) is a personality trait.

The most valid remaining possibility is that mapping strategy choice is related to personality. Leaning on the anecdotal knowledge of

the kids gained in Chapters 6 through 12 can allow us to assess what some
of these relations might be. Speaking solely in terms of group significance,
for example, it might be pointed out that the group leaders—Watson, and
especially Jencks—are Class 5 mappers; that Pagan, who had the power
to carry on with the project after Rome, was a Class 5 mapper; that
Abrams, who had the maturity to talk about his travel cycle after two
days in London, was a Class 5 mapper. That is, Class 5 mappers
exhibit certain types of maturity, and seem to have an inflated sense of
control, of themselves and others. At this point, the evidence is tenuous,
but cummulative.

At the other end of the scale Class 1 mappers seem to be,
particularly socially, somewhat immature. There can be little question
that Fisher, Baker, Lincoln, Mayo and Gordon lack comfort in the social
setting of the tour. Recall Gordon's conversation about the Rhinish
castles; Fisher's drunk scene in Innsbruck; the clannishness of Lincoln,
Baker and Mayo; their inability to effectively participate in the Roman
events, or to effectively articulate their reasons for withdrawal. These
are polar opposites to the activity and articulateness of the Class 5
mappers listed above. It may be difficult on the evidence to advance hard
opinions, but it must be easy to see that the variations between the kids in
choice of mapping strategies have parallels in other behavioral contexts.

At this stage we can do no more than assert the fact that
personality differences are better explanations of variations in choice of
mapping strategies than any of the other explanations advanced.

III

In this final section we shall present evidence concerning the
effect of the various environments on the behavior of certain pseudograph
measures. Most of this evidence is of an aggregate nature. However,
there is some individual evidence.

1) Individual evidence. This has been presented in the
foregoing section. The evidence concerns shifts in strategic choice
between London and Rome, and Rome and Paris. While it was pointed
out above that the environment played a limited role in the choice of
strategy, it was not pointed out just what this role was. First of all, all
reversions from Class 5 to a lower class took place in Rome. In the
second place, the kids employing identical strategies in Paris and London
both dropped to lower classes in Rome. This evidence is extremely
fragile, and yet supports the contention that Rome was a more difficult
city to cognize than was London. There is no contradictory evidence.
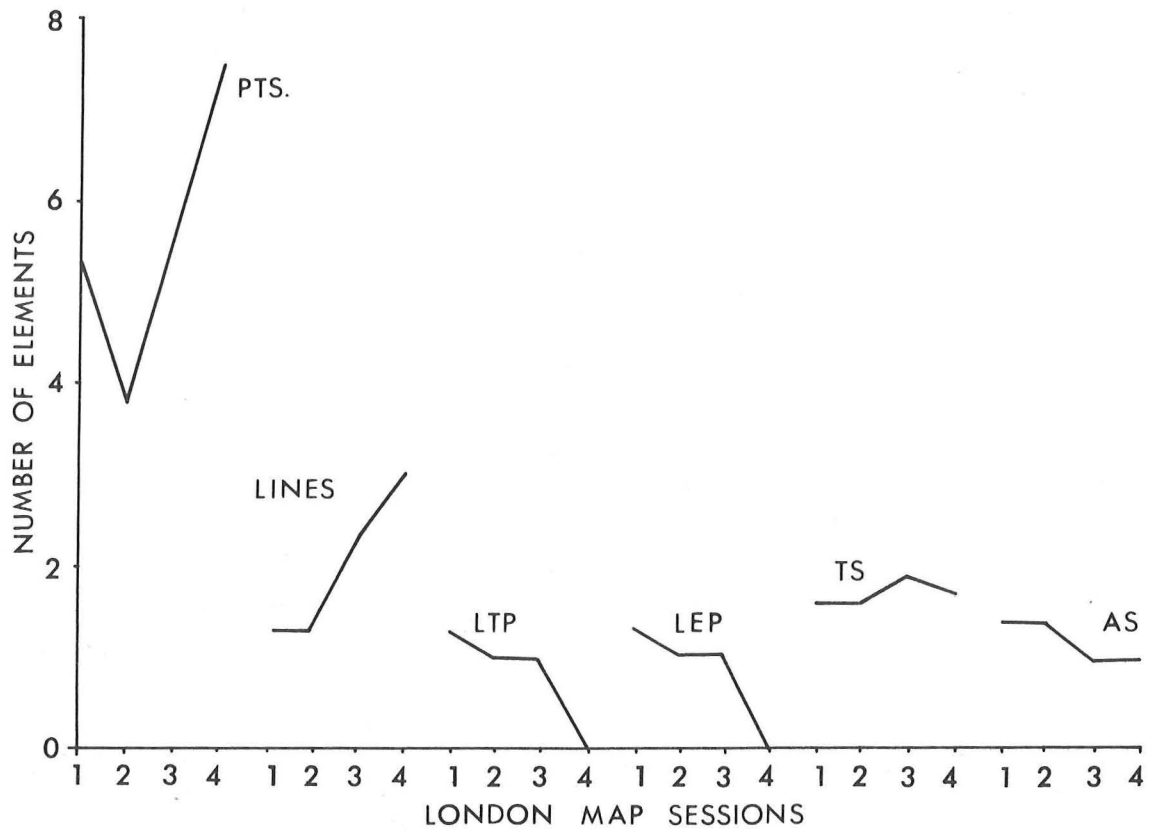The lack of Class 1 and 2 mappers in Paris—although this lack can be

Figure 15.16   Average number of elements for the London maps by element and map for all Group L maps (n-88)
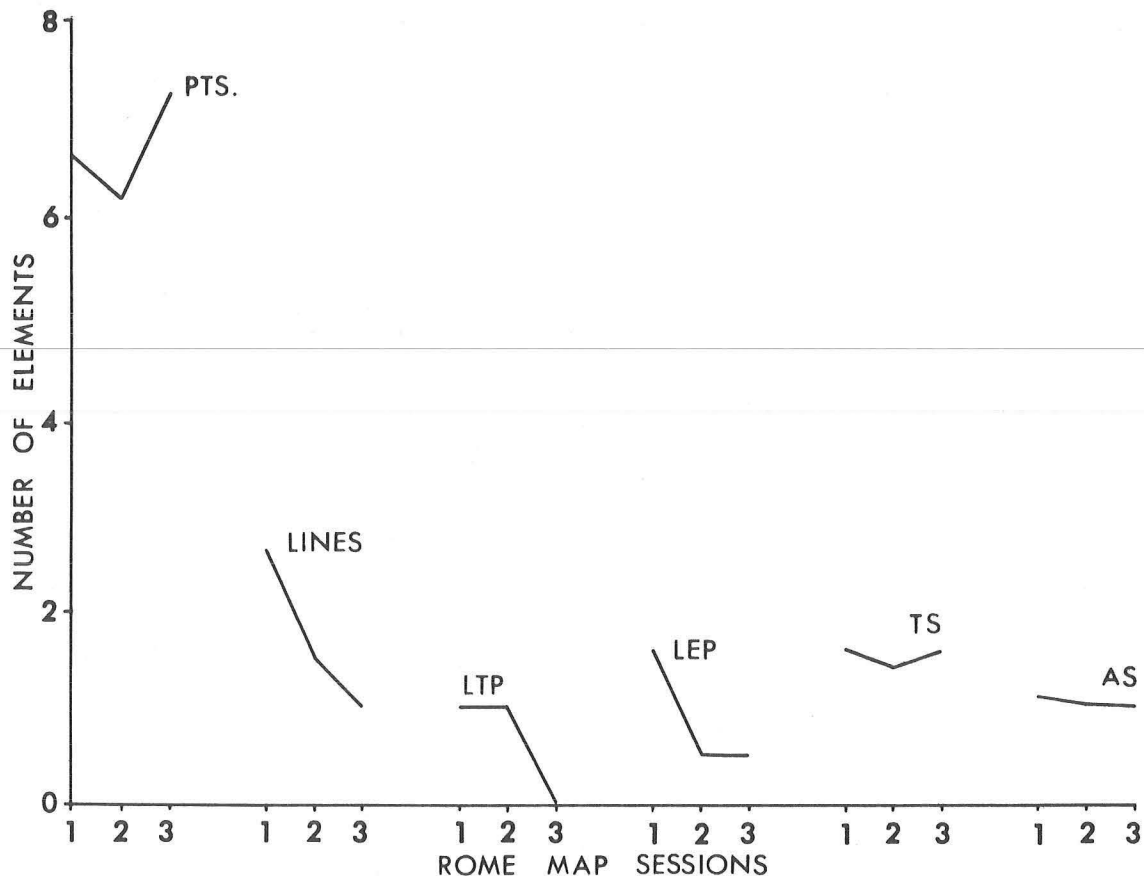
Figure 15.17   Average number of elements for the Rome maps by element and map for all Group L maps (n=88)

explained, perhaps more readily, on genetic grounds—is here adduced as supporting the contention that Paris was easier to cognize. There is no other individual evidence that speaks to environmental influence from the pseudograph analysis.

2) Aggregate evidence. The following three figures show the average number of each element for each map per city.

Figure 15.16 shows this for London. One thing that is striking is the way free floating points escalate in number after a serious drop on the second London map. Thus on the second London map there were 3.7 points per map, while on the fourth there were 7.5. This speaks of more sensory inputs than could be organized and integrated into an overall schema during the week in London. More was seen than could be intelligibly handled. Lines rise correspondingly. More roads were walked, passed, than could be connected. The sudden spurt on the last two sessions speaks of a desire to get it all down before it was too late, and thus there is a drop to zero of the intermediate elements, and a small, but noticible slackening in the use of trailing and actual subgraphs. London itself had a great deal to do with this, for these results are not paralleled in either Paris or Rome.

In Figure 15.17 we see the average number of elements per map for Rome. Comparing these figures with the London figures brings out several salient points. In the first place scant differences exist between the last four elements in the two cities. The average number of LTP's and LEP's drops sharply, while the number of TS's and AS's are slightly lower in Rome than London. When we turn our attention to the comparable sets of maps it is uniformly and significantly higher in Rome. The variations in the number of Rome points is nothing like the variation that we find in London. In the second place, the number of lines falls off in Rome, rather than growing as in London. Understanding the intentions of the kids to produce "good" connected maps in Rome, this is unexpected. The explanation of this anamoly must be sought in the other element of the kid-city interface, Rome.

And Rome certainly does demand a glance. Of the three cities involved in the extensive map operations, Rome is far and away the most difficult to cognize. In fact, it may not be too much to say that with the exception of a city like Tokyo, Rome is the most confusing and least well organized of the major cities of the world. Conceivably, this could be related to its ancient history, for it is probably the oldest of the world's major cities as well. It is at least a thousand years older than Paris or London, and in fact had been built and rebuilt (386 B.C.) before Paris or London were even sizable settlements. Descriptions of Rome at every

one of her ages emphasize the mess of the city. Thus Gutkind on Imperial Rome: "Rome continued on her way of disorder, or neglect of the justifiable ambitions of the masses, and in the self-deception that innumerable unrelated details would make an organic whole" (Gutkind, 1969, 423). Rome burned under Nero and was once again rebuilt (64 A.D.), just as chaotically, though with widened streets. With the arrival of the Christian era the focus of the entire city shifted, from the old Roman center, to the urban periphery where San Giovanni in Laterano (in the SE) and the Castel San Angelo and the Vatican (in the NW) were located. Under Sixtus V, Rome began to rebuild itself all over. The plans of Sixtus are musts in the urban planning business (see Bacon, 1967, 117-147, for a peculiarly adulatory example) and yet I find myself in sympathy with Gutkind who writes: "Why the admiration of the plans of the popes is almost a 'must' is difficult to understand. They were a rather haphazard conglomeration of unrelated details..." (Gutkind, 1969, 433). What they actually amounted to was a city with a plethora of centers, none of them wielding sufficient visual or functional authority to declare itself the center of Rome. In the 19th Century the French took over the city and reworked it, along lines better intentioned, but even less functionally successful; and of course Mussolini took a hand, building, for instance, the God-awful Via della Conciliazioni.

Thus a tourist in Rome is confronted by a city without a center, or several centers all shouting to him with equal strength. It is difficult not to accede to the authority of either St. Peter's, or the Piazza del Popolo, or the Piazza Venezia, or any of the other centers and there are many. In addition to this is the manner in which all variety of monument has been slapped next to one another. Thus we find absolutely adjacent the contemporary Monument to Vittorio Emanuele, the Baroque Piazza del Campigdolio, and the Roman Forum. Each is a perfect and articulate spokesman for its own time, but none of them speak for Rome. The result is a visual cacaphony that is difficult to cognize. And yet each of the centers, each of the monuments is an eye-catcher in its own right. Consequently the naive mapper ends up with a mind filled with points, each unrelated to each, and none connected together by a visual or intelligible network of streets.

The streets are the greatest difficulty of all for few of them run for more than a few blocks. The ones that do, like the Strada Olimpica and the Via Aurelia, give the impression of actually comprising a number of disjoint streets tied together by a common name. Thus they lack a character of their own and become difficult even to follow. The plans of the popes exacerbated this difficulty, slashing across preexisting street patterns with gay abandon. For all the intricacy of London, major streets had identifiable characters and wandered in given directions, and
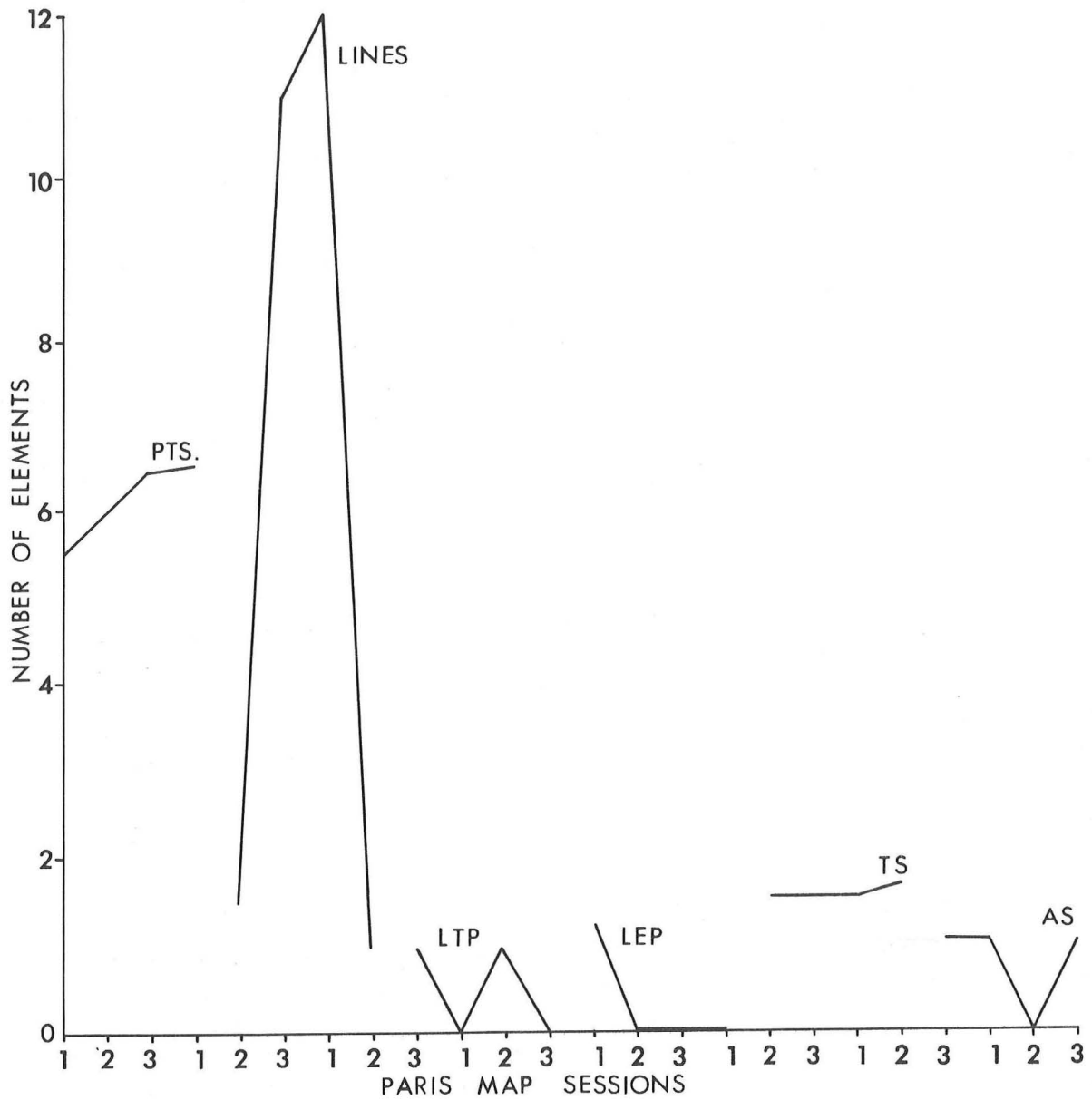
Figure 15.18 Average number of elements for the Paris maps by element and map for all Group L maps (n=37)

underlying its pattern was a felt north-south, east-west grid. Nothing underlies the pattern of Rome but ages of poor planning and the resultant compage is a nightmare. Now it is obvious that an exploratory system that operates in New York, or even London, will be of absolutely no use in Rome. Likewise, a mapping strategy that might have achieved laudatory results in London, has no chance whatsoever of success in Rome. And since we are looking at the interface of the kids (in flux) and the environment (totally different) we must anticipate the sorts of results we in fact found. This is a case when new bottles are demanded by new wines.

I suggest that the greater number of points is a direct result of the pointilistic character of Rome and that the lesser number of lines directly reflects the invisibility of an organic street pattern.

Figure 15.18 shows the average number of elements for maps of Paris. Four distinct features demand attention. Unlike London and Rome the number of points rises continuously. The LTP's rise on the third set of maps, while the AS's fall to zero. These anamolies, which are not overwhelming, may well be a function of either the small sample size (only eight kids) or the unusually high degree of motivation for these mappers (of not perfectly understood consequences). The average number of lines also behaves erratically here, and this is principally the result of the frequent occurrence on the second and third Paris maps of the twelve streets radiating from the Place de l'Etoile, all being drawn but none connected to anything else. With some justification these streets might have been regarded as point attributes, more a remark about the Place rather than streets in their own right. We have chosen to regard them as streets to preserve consistency in dealing with graphic content.

This is not, however, the whole of the explanation, for in point of fact, where Rome was a pointilistic city, Paris is a linear city, the city par excellance of boulevards and rues, and it is these that grab and absorb attention: St. Michael, Champs-Elysees, St. Germaine, Rue de Rivoli are but a few of the famous streets of Paris, the city known for its streets as no other city is. To an extent this linear character was insured by the work of Haussmann in the 19th Century, but it also resulted from a long history of linear development. The work of Haussmann is like that of Sixtus VI, ordinarily much praised by planners. In Paris it is, however, also vocally and self-consciously praised by Parisians and tourists alike.

If environmental differences were the major explanation for intercity variations, we would be unable to see connections between this

aggregate analysis and the earlier individual analyses. This, however, is not the case. In fact, the rise and fall of certain elements can be clearly related to the preponderance of one or another mapping strategy.

IV

Our conclusions are short and simple. The issue of the connectivity and degree of integration of the map surface is important, perhaps central to any discussion of mental maps. If the maps were susceptible of graph theoretic interpretation, it would be a powerful tool in this analysis. Unfortunately, our maps were not amenable to such analysis. The pseudograph provides an interesting and valuable surrogate. Using this device we are able to come to certain understandings of the relation of personality (subsuming learning and motivational attributes) and environment to mapping. In our analysis we have emphasized the explanatory power of the personality inputs, deferring final discussion of this issue until Chapter 19, while pointing out that the dynamics of integration among a series of maps can be sorted into five classes, which classes have certain genetic attributes and personality corrolates. Nonetheless, it can be shown that environmental variations do play a measurable role in the process of mapping novel environments.