Bulletin of the Psychonomic Society
1979, Vol. 13 (3), 183-186

Cognitive maps of a college campus: A new look at freshman orientation

JAMES F. HERMAN, ROBERT V. KAIL, and ALEXANDER W. SIEGEL
University of Pittsburgh, Pittsburgh, Pennsylvania 15260

College freshmen were tested for spatial knowledge of their campus after 3 weeks, 3 months, and 6 months of experience. Surprisingly, knowledge of landmarks, routes, and configurations was very good after only 3 weeks, and increased significantly up to 3 months; further increases in spatial knowledge were not significant. Males had significantly more landmark knowledge than females; however, males and females did not differ significantly on route and configuration knowledge. The results are discussed in terms of the importance of distinguishing various types of spatial knowledge and developing assessment techniques for each that are unconfounded by irrelevant performance factors.

Accurate way-finding in the large-scale environment seems to be guided by some form of internal mental representation of that environment (Downs & Stea, 1973). This mental representation can be called a cognitive map; it is an individual's organized representation of some part of the spatial environment. The characteristics of individual's cognitive maps of their cities was examined extensively by Lynch (1960), and considerable attention has been focused subsequently on the development of these maps in children and adults (Downs & Stea, 1977; Hardwick, McIntyre, & Pick, 1976; Herman & Siegel, 1978). Recently, Appleyard (1970) and Moore (1976) had adults give route descriptions and draw sketch maps of their cities; they found that the accuracy of these increased as a function of increased residence, but that even after several years of experience, the cognitive maps of adults were, overall, still distorted and fragmented. Unfortunately, these measures confound verbal and drawing ability with actual spatial knowledge. One purpose of the present study was to investigate changes in spatial knowledge of a large environment that occur with increased residential experience using a set of procedures that eliminate this confounding.

Siegel and White (1975) postulated that the essential types of spatial knowledge that comprise a cognitive map are landmarks, routes, and configurations. Landmarks are the salient locations, objects, and points of decision in an environment around which a person organizes his/her spatial activity. Routes are sensorimotor routines (lines of action) that guide an individual's travel between landmarks. Configurations represent the integration of different routes into a coherent, well organized structure. Siegel and White (1975) postulate that the three types of knowledge are hierarchical, with route knowledge dependent on landmark knowledge, and configurational knowledge dependent on both landmark and route knowledge. A second purpose of the present study was to assess each of these types of spatial knowledge and their development as a function of increased residential experience.

This research was supported by a faculty research grant from the University of Pittsburgh to R. V. Kail, and by NICHHD Grant 09694 to A. W. Siegel. We would like to thank J. Cica and E. M. Kail for their help in various phases of the data analysis. Requests for reprints should be sent to James F. Herman, Department of Psychology, Washington University, Box 1125, Saint Louis, Missouri 63130.

METHOD

Subjects

A total of 66 college freshmen participated as partial fulfillment of the requirements for an introductory course. All subjects lived on the university campus and had not visited the campus more than twice prior to the beginning of their freshman year.

Materials

Since undergraduates rarely, if ever, find it necessary to use 13 of the university buildings, only 34 of the 47 buildings of the University of Pittsburgh were included in the study. These 34 buildings are displayed in their numbered locations in Figure 1. The front of each building (including some of its surrounding land area) was photographed in color.

Procedure

The 66 subjects were tested in groups of 10 to 12. Twenty-two persons, 11 males and 11 females, were tested in the last weeks of September, November, and March. Thus, at the time of testing, the groups had been on campus 3 weeks, 3 months, and 6 months, respectively (excluding vacations for holidays). Each group was tested in two 1-h sessions separated by an interval of 2 days.

Day 1. Subjects were given three tests, each designed to assess knowledge of landmarks. First, they were given an unlimited amount of time to recall (on paper) as many campus buildings as they could. Then, in a recognition task, subjects saw the 34 slides of university buildings, each shown for 15 sec, and were instructed to write the name of each building on the appropriate line (numbered 1-34) of the answer sheet. Finally, subjects were shown the 34 slides again, in the same

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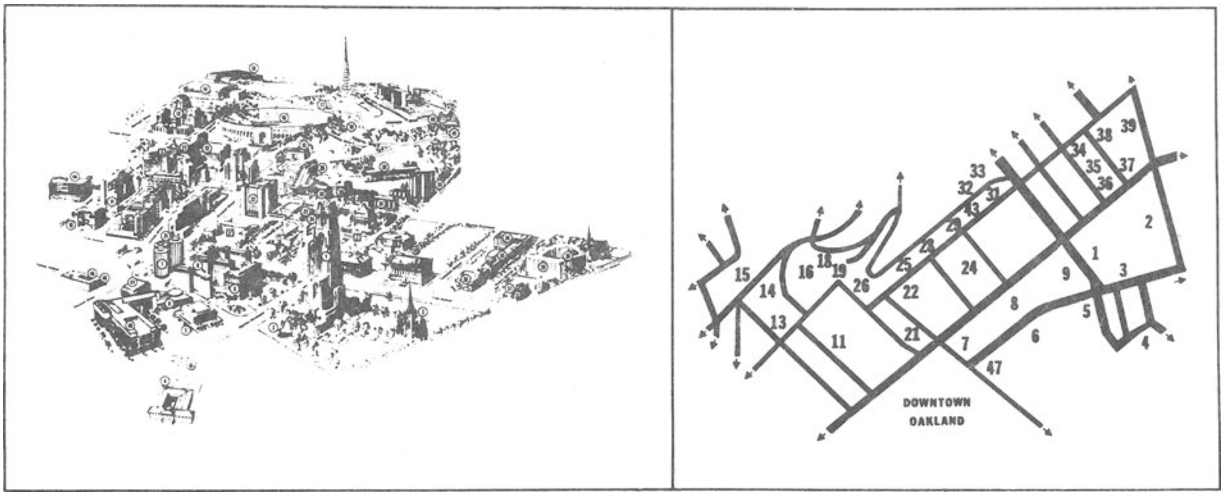

Figure 1. Three- and two-dimensional maps of the university campus.

order, and were asked to match the building depicted in the slide with the appropriate name from a list of the 34 buildings.

Day 2. Tests were given to assess knowledge of routes and locations of the buildings. Since these tests required knowledge of the name of a building, we selected only those buildings that were known by at least 80% of the subjects on Day 1. For each of the 34 buildings, an 80% average criterion level for a recall + recognition + matching score was established. If, for example, a building was recalled by 90% of the subjects, recognized by 70%, and matched by 80%, it would be included on the second day, since the average percent (80%) satisfied the criterion level. Employing this procedure, 10 buildings were used in the September group, 14 in the November group (including the 10 from September), and 18 in the March group (including the 14 from November).

To assess route knowledge, subjects were asked to provide written directions between various pairs of buildings for a fictitious visitor to the campus. They were told to be as specific as possible in giving directions, and to use other buildings, street names, street lights, and so on, to aid the visitor in finding his way. Four pairs were used in the September group, five pairs in the November and March groups (including the four from September). Pairs were chosen to maximize the area of the campus over which the subjects had to give directions.

To assess configurational knowledge, subjects were given a sheet on which each of the 10 (14, or 18) buildings was listed and underlined. Subjects were told to list the other $N - 1$ buildings below the underlined building in order of increasing distance from the underlined building. It was stressed that judgments should be made on direct distances between buildings and not walking distance. The September group judged all 10 buildings; in November and March, half the subjects judged half of the buildings relative to all others, while the other half of the subjects judged the other half of the buildings in relation to all others. This was done due to time constraints.

RESULTS

Three aspects of the results are of particular interest: subjects' knowledge of landmarks, their knowledge of routes, and their knowledge of the configuration of the campus. Each will be presented in turn.

Landmark Knowledge

Three measures of landmark knowledge were tabulated for each subject: the number of buildings recalled, recognized, and matched. The means for each measure are shown in Table 1. For all three measures, landmark knowledge increased with greater experience on the campus [$Fs(2,60) \geqslant 10.28$, $p < .01$]. In each case, knowledge increased from September to November, but did not change significantly thereafter (based on Scheffé comparisons; $p = .05$). Men's knowledge of landmarks exceeded that of women on all three measures, and did so significantly for recall and recognition [$Fs(1,60) \geqslant 4.55$, $p < .05$].

Route Knowledge

Each subject's description of a route was given a score ranging from 0 to 6 by two raters who were highly familiar with the campus. A score of 0 was assigned if the subject was unable to describe the route at all; 6 corresponded to a perfect description. Intermediate values were given based on the proportion of the route that was described accurately. For example, 3 indicated that a subject had described about half of the route accurately. Interrater reliability with this scoring system was quite high ($r = .92$, $p < .01$).

The overall means of the four September routes for the three testing periods differed significantly [$F(2,60) = 5.47$, $p < .05$]. Knowledge of these four routes increased from September (4.43) to November (5.10), but not between November and March (5.12). The overall mean for the five November routes (4.66) did not increase significantly in March (4.68) ($F < 1$).

Table 1
Three Measures of Landmark Knowledge

	September		November		March	
Measure	Mean	SD	Mean	SD	Mean	SD
Recall	15.05	1.96	17.90	2.86	18.73	3.56
Recognition	12.59	2.59	17.05	3.70	16.73	4.23
Matching	13.91	2.67	19.36	4.33	18.59	4.84

Note–For each mean and standard deviation, N = 22.

This pattern of change is exactly what was found with the various measures of landmark knowledge. Thus, it again seems that much of a student's knowledge of the campus is acquired during the first 3 months on campus. In fact, subjects were remarkably accurate (75%) in their knowledge of the routes after only 3 weeks.

No sex differences were found in knowledge of routes [$F(1,60) \leq 1$]. Thus, males' advantage on spatial tasks of this nature appear to be limited to general landmark knowledge.

Configurational Knowledge

From subject's rank order of distance between N buildings, an N by N matrix was constructed, representing all possible comparisons between buildings. For each of the comparisons, the ranks were summed; multidimensional scaling was then performed. (The nearly identical male and female results were combined.) Due to an error in the preparation of the data sheets for the November groups, these analyses were limited to the September and March groups.

The results of the scaling analyses are presented in Figure 2. Open circles depict the actual locations of the buildings on campus; solid circles represent, in effect, subjects' cognitive maps of the campus. What is most impressive about both panels of Figure 2 is the close correspondence between the actual and scaled locations of the buildings. After only 3 weeks on campus, college freshmen have very accurate cognitive maps of the salient features (i.e., landmarks) of that environment. However, each of the 10 buildings used for the September group was located more accurately in the March group. Furthermore, the four buildings added in March were also located with considerable accuracy. It would appear that configurational knowledge was established after only a few weeks on campus and became much more "finely tuned" and elaborated between September and March.

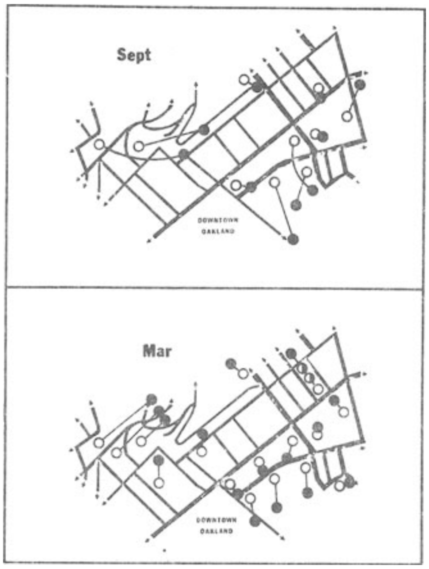

Figure 2. Multidimensional scaling analyses based on the rank orders of distances between buildings. Open circles indicate actual locations of the buildings; solid circles indicate locations derived from the scaling. Stress values are .17 and .21 for September and March, respectively.

DISCUSSION

Our principal finding was that landmark, route, and configurational knowledge of a university campus was quite accurate after only 3 weeks experience and became increasingly "finely tuned" and elaborated during the next 2 months; further increases in spatial knowledge were not significant. This result is somewhat surprising, particularly in light of research by Appleyard (1970), who found that adults' cognitive maps of their neighborhoods were often distorted or fragmented markedly after several years of experience. Two critical procedural differences between our research and Appleyard's probably account for the difference in results. First, route and configurational knowledge presuppose landmark knowledge; that is, one must first know a landmark (it must be familiar) before he/she can know it as an origin or destination of a route, or as a part of an integrated map of the environment (Siegel & White, 1975). Consequently, route and configurational knowledge can be assessed only with landmarks that are known. Subjects in the present study were tested for route and configurational knowledge regarding only known landmarks. Appleyard (1970) required his subjects to draw sketch maps of areas in which landmarks were not necessarily known; thus, it is not surprising that the maps were not terribly accurate. Second, having a subject draw a sketch map of his/her knowledge of the spatial layout of the environment seriously confounds spatial knowledge with drawing ability or the more general ability of "externalizing" spatial knowledge. Lack of drawing skill is but one of the problems with drawn maps that may lead to an underestimation of a person's spatial knowledge (Kosslyn, Heldmeyer, & Locklear, 1977). These problems were minimized in our research by using procedures for assessing spatial knowledge that eliminated confounding of spatial knowledge and praxic ability.

More generally, we have shown that it is possible to follow changes in the acquisition of spatial knowledge of a real-world environment over an extended time period by using "in situ" techniques. This situational experimentation seems necessary if we are to understand the nature and acquisition of spatial representations of large-scale environments. Our results also point to the need to distinguish among various types of spatial knowledge, and to the necessity for devising different techniques for their assessment.

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(Received for publication January 3, 1979.)