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Recall Memory for Topographic Maps and Natural Terrain: Effects of Experience and Task Performance

DANIEL R MONTELLO

Department of Geography University of California, Santa Barbara / United States

CATHERINE N SULLIVAN AND HERBERT L PICK, JR.

Institute of Child Development, University of Minnesota / United States

Abstract Two experiments were conducted to examine the recall of information from natural landscapes and topographic maps. In Experiment 1, the nature of information recalled from photos of landscape scenes by experienced and novice topographic-map readers was influenced by the performance of a map-matching task, but did not vary much as a function of experience with topographic maps. In Experiment 2, the nature of information recalled from topographic maps by experienced topographic-map readers was not influenced by the performance of a scene-matching task, but did vary somewhat as a function of experience with maps. The results are explained by reference to the contexts in which specialized knowledge that develops as part of experience with topographic maps will be activated. Characteristics of this specialized knowledge are discussed, as are proposals for further research on the information-processing that occurs during map use.

TOPOGRAPHIC maps commonly depict "vertical" information about terrain (information about slope and altitude) by means of contour lines — isolines of altitude that can be interpreted to show landform relief features. The interpretation of relief from patterns of contour lines is no trivial task. The patterns are highly symbolic in that contour lines are a largely arbitrary representation of relief changes, and they require considerable training and/or practice to interpret effectively. Because of the complexity of interpreting patterns of contour lines, and the importance of this skill in tasks such as navigation, we expect the study of topographic map comprehension to be a rich domain for understanding some of the perceptual and cognitive processes underlying map use.

Researchers from a variety of disciplines (geography, cartography, psychology, education, mathematics and computer science) have been interested in the comprehension and use of maps. The wide variety of issues addressed includes such topics as problem-solving strategies when using maps (Crampton, 1992; Griffin, 1983), attentional shifts as measured with eye movements (Steinke, 1987), the depiction and interpretation of contour representations (Eley, 1992), the development and education of map-reading abilities (Downs and Liben, 1990), and others. The research reported here investigates memory for landscape scenes and for related topographic maps. How is such memory and information processing related to experience with topographic maps, and how is it affected by the performance of a task requiring the matching of maps and landscapes?

Literature

Much of the existing research on maps has been concerned with elucidating the learning strategies of people asked to study maps, often in order to examine the relationship of cartographic training or experience to learning strategies (e.g., Thorndyke and Stasz, 1980). For example, Kulhavy, Pridemore, and Stock (1992) found some evidence that cartographically trained subjects used more thematic information (as opposed to base-map information) in learning and recalling a planimetric map of ancient Mayan trade goods and routes. Of more direct relevance to the present research, Kinnear and Wood (1987) examined incidental recognition memory for topographic maps by a sample of subjects varying in their experience with topographic maps. Half of the subjects merely learned the maps without performing any other task, while the other half performed several tasks with the maps that required interpretation of the contour information on those maps. The performance of these tasks was associated with improved recognition memory for the maps on a subsequent forced-choice task; greater prior experience was not significantly associated with improved recognition. The authors also noted the prevalence of references to "valley" features rather than "hill" features in comments written by subjects.

In subsequent research, Gilhooly, Wood, Kinnear, and Green (1988) compared experienced and inexperienced topographic-map readers on an intentional memory task in which they learned either topographic or planimetric maps. Self-reported experience and

DANIEL R. MONTELLO is Assistant Professor; CATHERINE N. SULLIVAN is a doctoral student; HERBERT L. PICK, JR. is Professor.

training with topographic maps was found to correlate .67 with performance on topographic map problems in a pretest. The two subject groups did not differ in the accuracy of their answers to subsequent multiple-choice questions about information on the planimetric maps, replicating a negative finding by Thorndyke and Stasz (1980). More experienced subjects were more accurate on questions about the topographic maps, however. Similarly, the two subject groups did not differ in the information they recalled by sketching the planimetric maps, nor in their recall of non-contour information on sketches of the topographic maps. The experienced subjects did recall more contour information from the topographic maps. These results were replicated in a second study in which subjects performed a concurrent verbal protocol while learning a topographic map and sketching it from memory. As in Kinnear and Wood (1987), there was again some indication of greater attention by both subject groups to valleys and low areas than to hills and high areas.

The discussion above suggests that map-use research has generally focused on the map itself. It has not focused much on the processing of information in the world that occurs when the maps are used during tasks such as navigation (Blades, 1991, reviews some work with children on maps and navigation). The processing of information in the world is an interesting issue, however, because map use often requires perception (or interpretation) of both map and environmental information, in addition to a "matching" or comparison of the information from the two sources. There has been some research on the perception and memory of natural- and built-environmental scenes, presented photographically or in drawings (e.g., Hock and Schmelzkopf, 1980). In an interesting study, Mandler and Parker (1976) had subjects perform immediate or one-week delayed recognition and reconstruction tasks with scene pictures that were or were not scrambled. Memory for object locations along the horizontal axis of the scenes declined after one week, whether the scenes had been scrambled or not. Memory for locations along the vertical dimension, however, declined only for the scrambled scenes. The authors interpret this by reference to "real-world schemata" in memory; presumably, there is a natural ordering of objects along the vertical dimension (due to gravity) that does not exist along the horizontal. Such an explanation is reminiscent of ideas about specialized schemata used by experienced map readers (e.g., Gilhooly et al., 1988; Williamson and McGuinness, 1990).

Some research that directly addresses the issue of map–world processing is reported by Pick, Heinrichs, Montello, Smith, Sullivan, and Thompson (in press). They examined the use of topographic maps by experienced map readers to solve navigation problems. Subjects provided a concurrent verbal protocol while performing a localization task in a field setting. Several problem-solving strategies were identified as being associated with success or failure at matching terrain information with map information in order to determine location on a modified USGS topographic map. In addition, these authors noted the predominant use of topological and qualitative spatial relational terms, such as "next to" and "close–far," rather than explicit quantitative terms about slope, size, and distance. The use of explicit quantitative terms was more common when describing the map than when describing the surrounding terrain, however. Subjects were also frequently found to use configurations of features ("a hill with a valley right behind it") rather than single features to evaluate map-terrain matching hypotheses. Also, subjects were found to focus more on nearby terrain features than on distant features. Finally, Pick et al.'s subjects were faced with looking back and forth between the terrain and the map if they could not remember what had been seen. This makes it evident that the ability to remember, for shorter or longer durations, what the terrain looks like and what information is available on maps is very useful in many navigation tasks.

Present Research

Two studies of the processing of landscape and map information are reported below. The first examined recall memory for photographically presented natural landscapes as functions of topographic-map experience and the performance of a matching task involving topographic maps. The second study was largely the converse of the first: Recall memory for topographic maps was examined, again as functions of map experience and the performance of a matching task (involving landscape scenes).

Specific questions we address in this research include:

1. What is the content of information recalled from landscapes and from topographic maps (i.e., what is attended to; how are continuous landscapes and maps organized into discrete features; how accurate and complete is the information)?

2. How does the content of recalled information from landscapes and maps differ as a function of experience with topographic maps, and how does it differ as a function of performing a matching task with landscapes and maps?

3. How much information about the locations of landscape and map features is explicitly recalled, and what are its characteristics (i.e., how much is quantitative; how much refers to distance as opposed to direction; how much is perspective-dependent)?

4. How does recalled locational information differ as functions of map experience and the performance of a matching task?

5. How much information about intrinsic spatial attributes of landscape and map features (i.e., size, shape, slope, altitude) is explicitly recalled?

6. How does recalled information about spatial attributes differ as functions of map experience and the performance of a matching task?

7. How successfully can map users match landscapes to viewing directions depicted on topographic maps when

either the landscapes or maps must be recalled from memory, and how are aspects of the recalled information related to the quality of performance of such a matching task?

Experiment 1

In our first experiment, we examined recall memory for photographically presented natural landscapes. After viewing a landscape photograph for a brief time, subjects described and sketched it from memory. Experienced users of topographic maps were compared to novices who had no such experience. In addition to the landscape recall task, a second group of experienced subjects also performed a matching task with portions of topographic maps showing the areas depicted in the landscape photographs. This design allowed us to examine separately the influences of prior map experience, and the task demands of performing a map-matching task on the perception and memory of landscape features.

METHODS

Subjects

A total of forty-eight subjects participated in exchange for a payment of five dollars each. Of the forty-eight, thirty-two were recruited because of their experience using topographic maps. Most of the experienced subjects were students (of geology, archeology, and landscape architecture), backpackers, orienteers, or members of the military. They reported a median of thirty-two (mean of 286) days of experience using topographic maps in the field (any use during the day counted as one day), with a minimum of three and a maximum of 4,500 days. In addition, formal training in the use of topographic maps was quantified: 1: no training or no more than one day, 2: up to one quarter course, and 3: more than one quarter course. Mean reported training was 1.9 on this scale. The remaining sixteen subjects were recruited because of their lack of experience with topographic maps; none had any prior experience or training in them.

The experienced map users were divided randomly into two groups of sixteen subjects each: a *user recall-only* group and a *user-matching* group. The inexperienced subjects constituted a third group *(non-user recall-only)*. Subjects in all three groups viewed and tried to memorize landscape scenes for subsequent recall. In addition, subjects in the user-matching group performed a map-matching task described below. The two experienced groups did not differ significantly in days of experience or in amount of training. The mean age of subjects was 32.4 years. There were 19 females and 29 males distributed almost equally among the three groups.

Materials

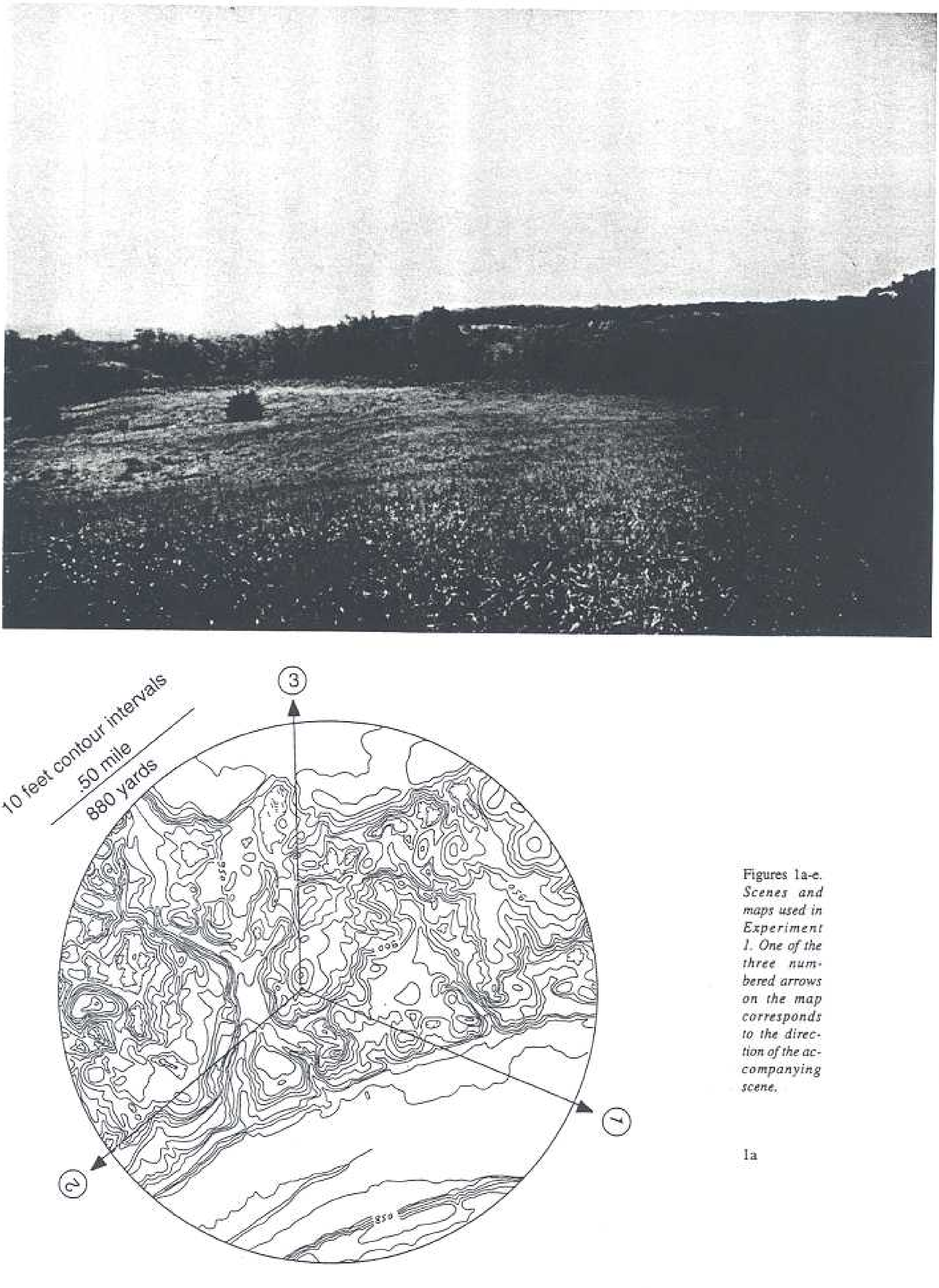
Landscape photos and maps were drawn from the materials described in Pick et al. (in press). Five landscape photos (scenes) were used as stimuli (a sixth was used for practice). These were colour-photographed views taken at five locations in predominantly natural areas. The camera was levelled and the focal length was 50 mm (minimal distortion). Three of the locations were in areas of gently rolling hills in Minnesota; the other two were in areas of more pronounced terrain in New Mexico and Arizona. Black-and-white versions of the five scenes are shown in Figures 1a–1e.

In addition to the scenes, subjects in the user-matching condition saw circular portions of topographic maps, centred at the location from which the scenes were photographed. The maps were black-and-white copies of USGS topographic maps. Because we were specifically interested in the processing of terrain information, all cultural information (roads, trails, houses) was removed. No vegetation was shown on the maps. The external boundary of each map was chosen to correspond approximately to the distance to the visible horizon in each scene. Once this boundary was selected, each map was enlarged or reduced to an approximate common diameter (about 16-18 cm). Information allowing the maps to be aligned with the cardinal directions (e.g., the grid lines) was removed, and elevation labels were reoriented on the maps. Each map was presented to subjects in a single random orientation, not necessarily with north at the top. Distance scales and contour intervals were present on the maps. Three direction arrows were drawn on these maps (labeled 1, 2, or 3), evenly spaced from each other and radiating from the centre location. One of the three pointed in the direction from which the corresponding scene had been photographed. The maps corresponding to the five test scenes are shown in Figures 1a–1e.

Subjects used a pen to sketch what they recalled of the scenes on blank 8.5" x 11" sheets of paper. Their verbal descriptions were tape-recorded. The slides were presented to the subject on a rear-projection screen in a darkened laboratory room. The size of the projected slide was about 160 x 105 cm. Subjects sat at a desk about 120 cm away from the screen. A reading lamp illuminated the desk from behind. A stopwatch was used to time the various phases of the procedure.

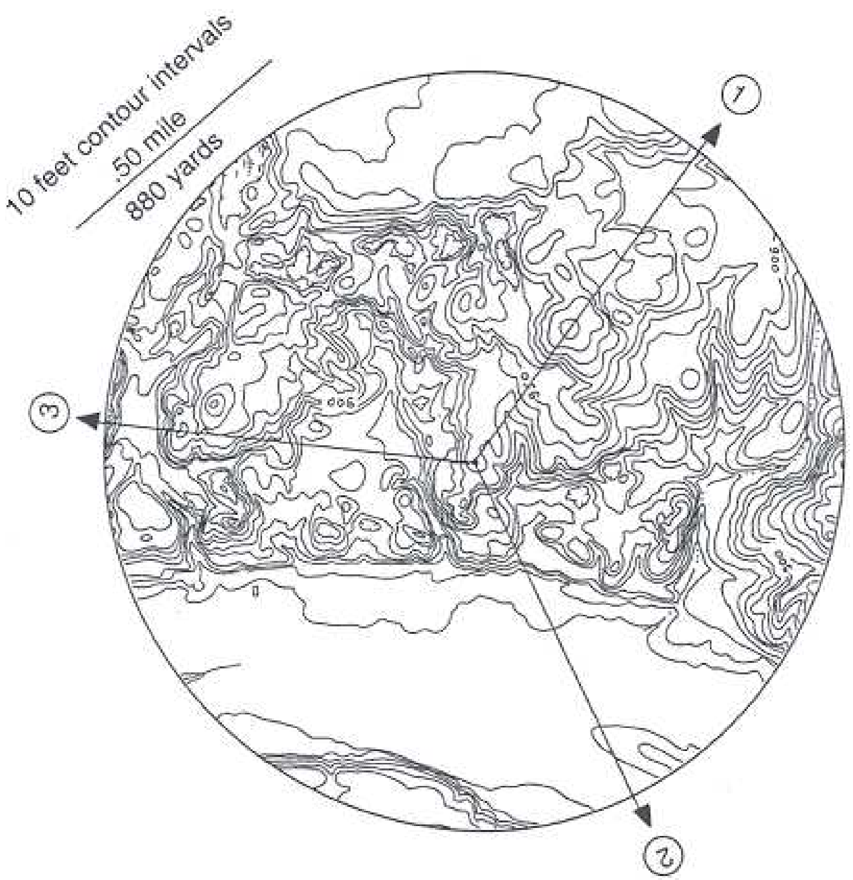
Procedure.

Subjects were tested individually. After arriving, they answered questions about their experience and training with topographic maps. Subjects were then taken to the testing room, where their task was described. The task began with a practice scene. They were told they would have to describe what they remembered of landscapes projected on the screen in front of them. When the slide appeared, they were to "look at it and try to remember it." In order to increase generalizability, two viewing times (fifteen and thirty seconds) were counterbalanced across conditions. After the slide disappeared, a delay period of three minutes took place; conversation unrelated to the study occurred during the delay. The delay period was used so that scenes would be recalled from long-term memory, rather than a more temporary working memory.



Figures 1a-e. *Scenes and maps used in Experiment 1. One of the three numbered arrows on the map corresponds to the direction of the accompanying scene.*

1a



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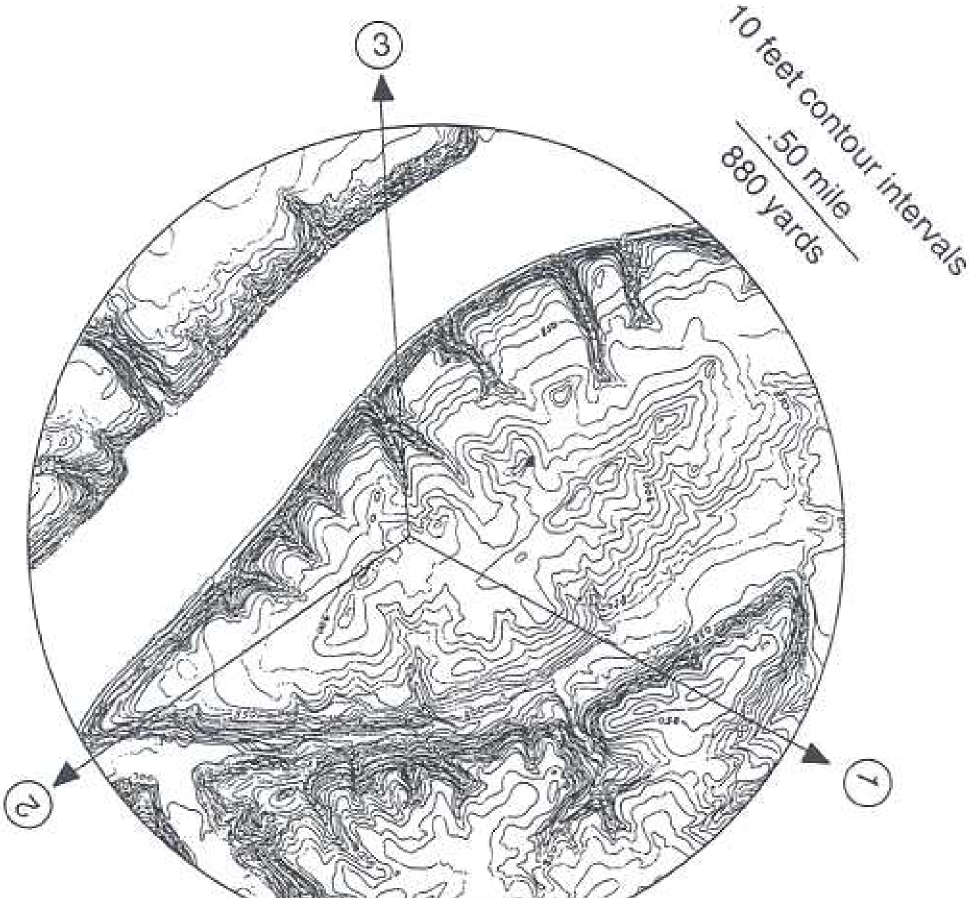

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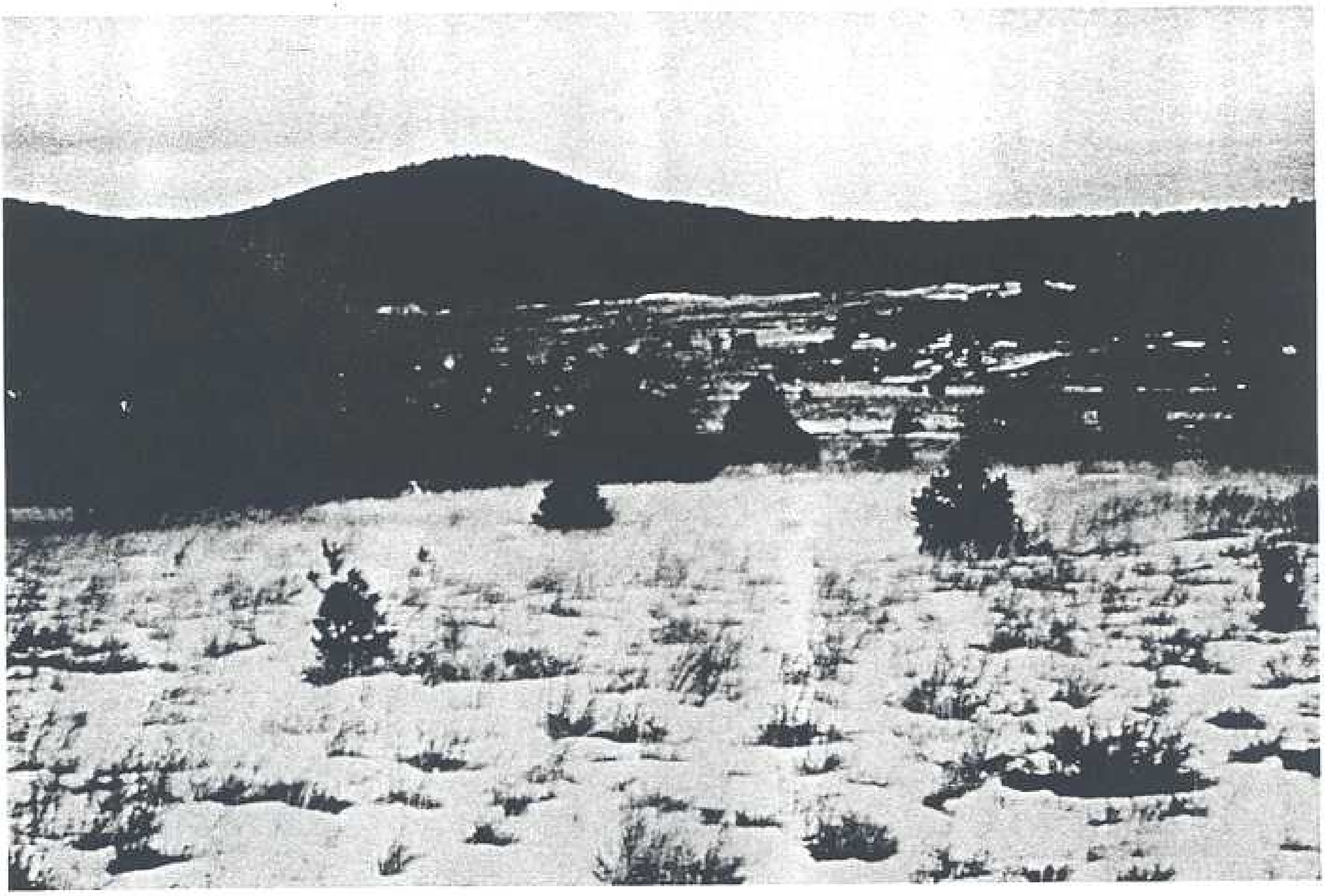

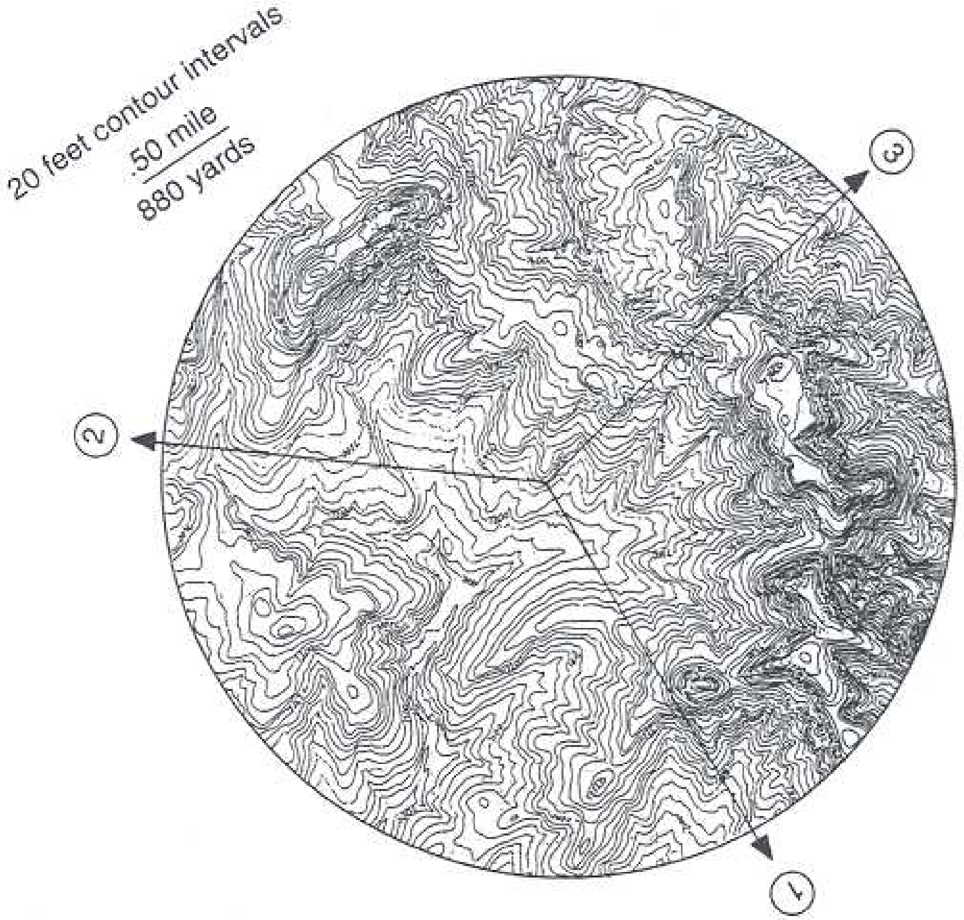

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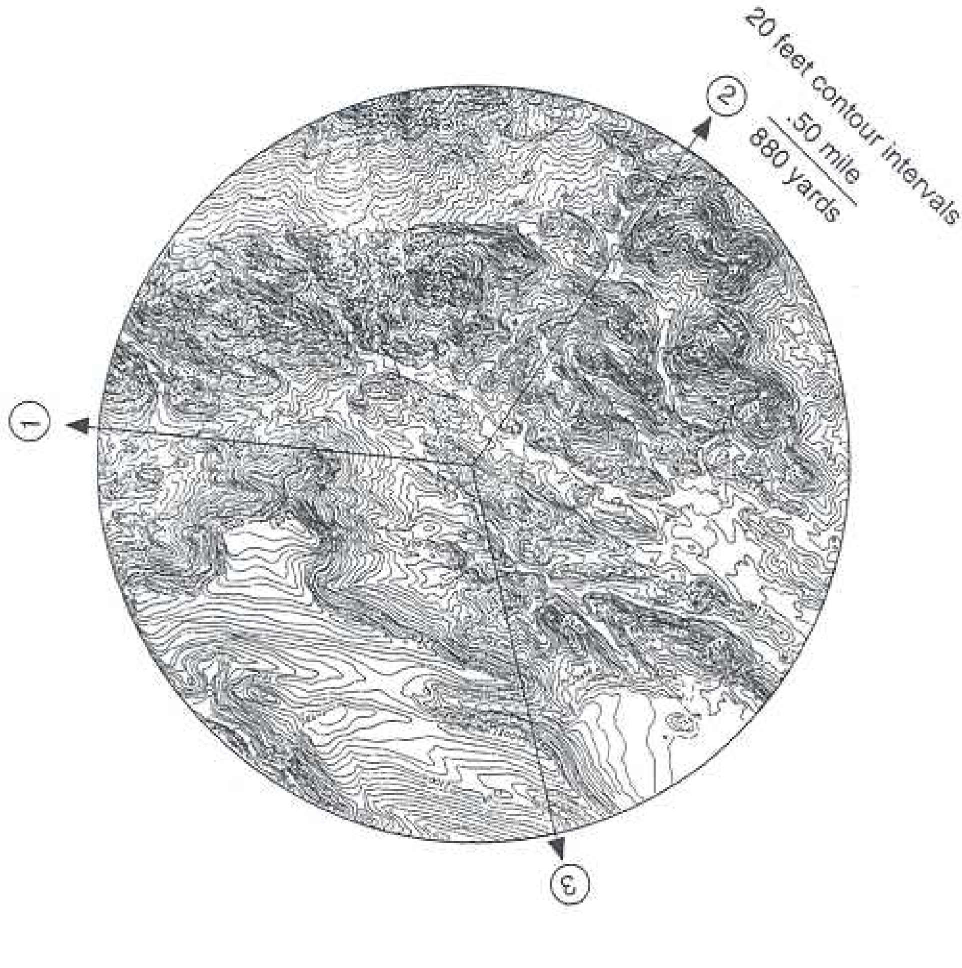

1e

After the delay, subjects recalled the scene by sketching a picture of it as they verbally described what they were drawing (the description was tape-recorded). They were given two minutes to "recall the landscape as precisely as you can." During this two-minute period, subjects were informed when thirty seconds remained. It was stressed that artistic merit was irrelevant. Subjects were told to describe everything they could recall from the scene; in particular, subjects in the user-matching group (described below) were told not to restrict themselves only to terrain features as shown on topographic maps. Subjects were asked to number aspects of their sketches and state the numbers aloud; this later assisted us in matching sketched features to verbally described features. During the recall period, subjects were asked to imagine themselves standing at the location where the scene was photographed, and to describe a three-dimensional scene with depth, rather than a flat picture. During the initial practice scene only, subjects were prompted if they were not adequately verbalizing or numbering, or if they described the scene during recall as a flat photo (e.g., saying things such as, "... at the bottom of the picture"). After the practice scene was completed, the five test scenes were begun. The scenes were presented in different random orders for each subject in an experimental condition. The same orders were repeated across the three subject groups and two viewing times (counterbalancing order across conditions).

During instructions for the practice scene, subjects in the user-matching group were also told they would perform a matching task that required them to match the recalled scenes to viewing directions depicted on topographic maps. Special characteristics of the maps and the matching task, including the fact that north was not necessarily at the top, were described to subjects. They were told that the scenes they would see were photographed from a point at the *centre* of the map, by a person facing in one of the three directions indicated by the arrows. After sketching and describing each remembered scene, they were given the map corresponding to that scene. Subjects were told to match the scene (from memory) to the arrow they thought showed the direction in which the scene was photographed, indicating their responses by stating the number of the arrow. Both speed and accuracy of response were stressed to subjects and recorded by the experimenter.

Scene Recall Coding

A coding system was developed in order to interpret the transcribed verbal recalls (full details are available from the authors). The verbal recalls provided the majority of results to be analyzed, though sketches were frequently used to remove ambiguity about the referent of the verbal description (the ordinal accuracy of feature placement was coded from the sketches). A sample recall, transcribed and coded, is presented in Table 1. The corresponding sketch is presented in Figure 2.

Recalls were first analyzed into discrete features, an object or place (i.e., something represented by a noun) we deemed to be described as part of a single unit. These did not necessarily correspond to features as numbered by subjects (e.g., a statement such as: "There's a line of hills, I'll number them 3, 4, and 5 ..." was coded as one feature). Verbally-described features were classified into one of seven *feature-types* (examples in parentheses): (1) *terrain* (hills, valleys), (2) *vegetation* (grass, trees), (3) combination *terrain-vegetation* (meadows, hills with trees), (4) *human*/cultural (roads, people), (5) *atmospheric*/meteorological (clouds, snow), (6) *geological* (sand, rocks), and (7) *wrong*/indeterminate. In addition to this classification into feature types, terrain and terrain-vegetation features were further coded as *single-element* (hill, rise) or *multiple-element* (series of mounds, grassy slopes). Terrain and terrain-vegetation features were also coded into one of five *terrain-types:* (1) *hill,* (2) *flat,* (3) *valley,* (4) *slope,* (5) *mixed.* These are derived from the terrain categories identified

Table 1 Sample Coding of Recalled Scene from Experiment 1

Subject: "***In front*** **there is a meadow.**[1] **There's a *small* tree right here**[2]...that's #2, meadow's #1. And the meadow *slopes* down *into a valley* **over here which is forested.**[3] That's #3. **And *behind* the forest there's another meadow**[4], #4. **And *behind that* again is a ridge *line* of trees**[5], #5. **And *off to the left* it may have *sloped down*...that was #6...it may have been a descending hill *on the other side* but it was impossible to tell.**[6] **And, uh, *right in front* here was a *very shallow*** hill[7]...I'm going to call it hill #2...move this 1 over here so it's clear. **And everything here seemed to, if I remember right, may have *descended to my left***[8]...in the direction of this arrow, which is #6."
Experimenter: "6 was your...?"
S: "To the arrow. The descending direction."
E: "You've got 30 seconds. Anything else?"
S: "No, that's it."

Features

[1]terrain-vegetation (single-element slope-type)
[2]vegetation
[3]terrain-vegetation (single-element valley-type)
[4]terrain-vegetation (single-element flat-type)
[5]terrain-vegetation (multiple-element hill-type)
[6]wrong/indeterminate
[7]terrain (single-element hill-type)
[8]terrain (single-element slope-type)

Locational Terms

Metric distance perspective-dependent: *right in front*
Topological perspective-independent: *into a valley; on the other side*
Topological perspective-dependent: *In front; behind; behind that; off to the left; to my left*

Spatial Terms

Terrain: *meadow slopes down; ridge line; sloped down; very shallow hill; descended*
Non-Terrain: *small tree*

Note. Scene b. Subject was in the user-matching condition (75 days of field experience, no formal training). Numerical labels verbalized by subjects were used to guide coding but often did not correspond to feature numbers as assigned by experimenter. Redundant verbalizations were not coded. Sketch of this scene is shown in Figure 2.

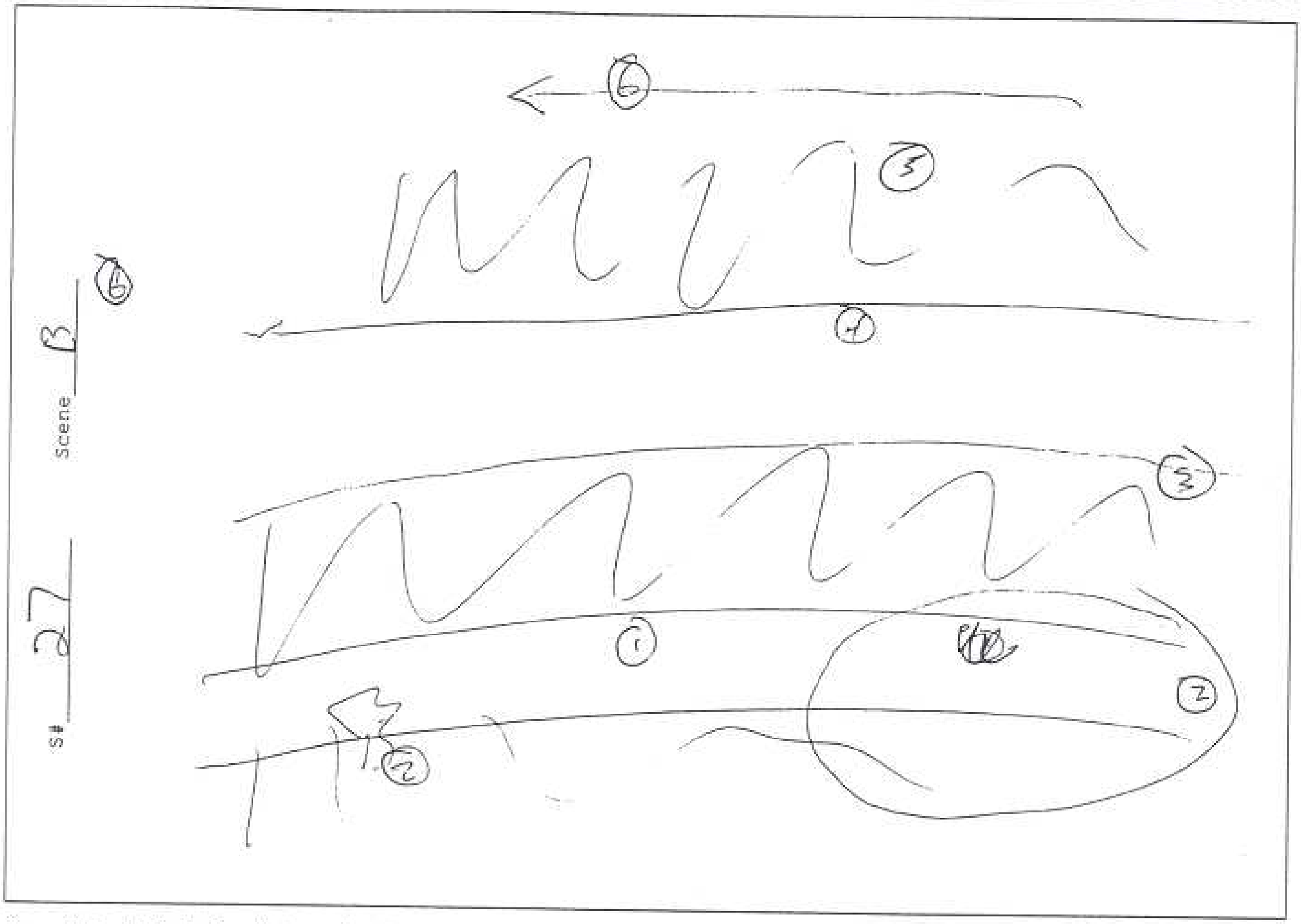

Figure 2. *Sample sketch of recalled scene from Experiment 1. Verbal recall recorded during this sketch is transcribed and coded in Table 1.*

in the protocols of experienced map users analyzed by Pick et al. (in press).

Terms or phrases that explicitly described something about the location of a feature were then coded as *locational terms*. These terms were classified as *metric* or *topological* (meant in a geometric sense). Metric terms express quantitative properties of space while topological terms express non-quantitative properties such as connection or adjacency. Pick et al. (in press) had observed the relative paucity of explicit quantitative metric relational terms in their protocols; instead, topological and qualitative terms were much more common. We decided to include as metric terms not only explicit quantification ("ten feet beyond," "about thirty degrees to the right") but also terms that we interpreted as expressing quantitative location, even though only implied or imprecise ("way off to the left," "right next to"). Metric terms were further divided into *distance* and *direction* terms. As opposed to metric terms, topological terms expressed non-quantitative aspects of location ("beyond", "next to"), including unmodified uses of "left" and "right." Both metric and topological locational terms were further classified according to whether they implicitly or explicitly involved reference to the viewer's location: *perspective-dependent* ("far from me," "to the right of") or *perspective-independent* ("forty feet below," "near the tree").

Terms or phrases that described something about intrinsic spatial characteristics of a feature were coded as *spatial terms*. These included statements about size, shape, number, and steepness. *Terrain* terms referred to terrain or terrain-vegetation features; *non-terrain* terms referred to any other feature.

In order to assess coding reliability, the independent results of two trained and practiced coders on a randomly chosen subset of the data were compared. Reliability was generally quite high in this subset, for example, 95% agreement on the number of features, 91% on the number of terrain features, and 89% on the number of vegetation features.

RESULTS

To determine an overall pattern of differences between the three conditions, we first examined all of the dependent variables simultaneously in a Multivariate Analysis of Variance (MANOVA). This included the proportions of recalled feature types, terrain types, and spatial terms. Because we had no particular interest in differences between the five landscape scenes and the two viewing times, but included them in our study in order to increase the generalizability of the findings, analyses were

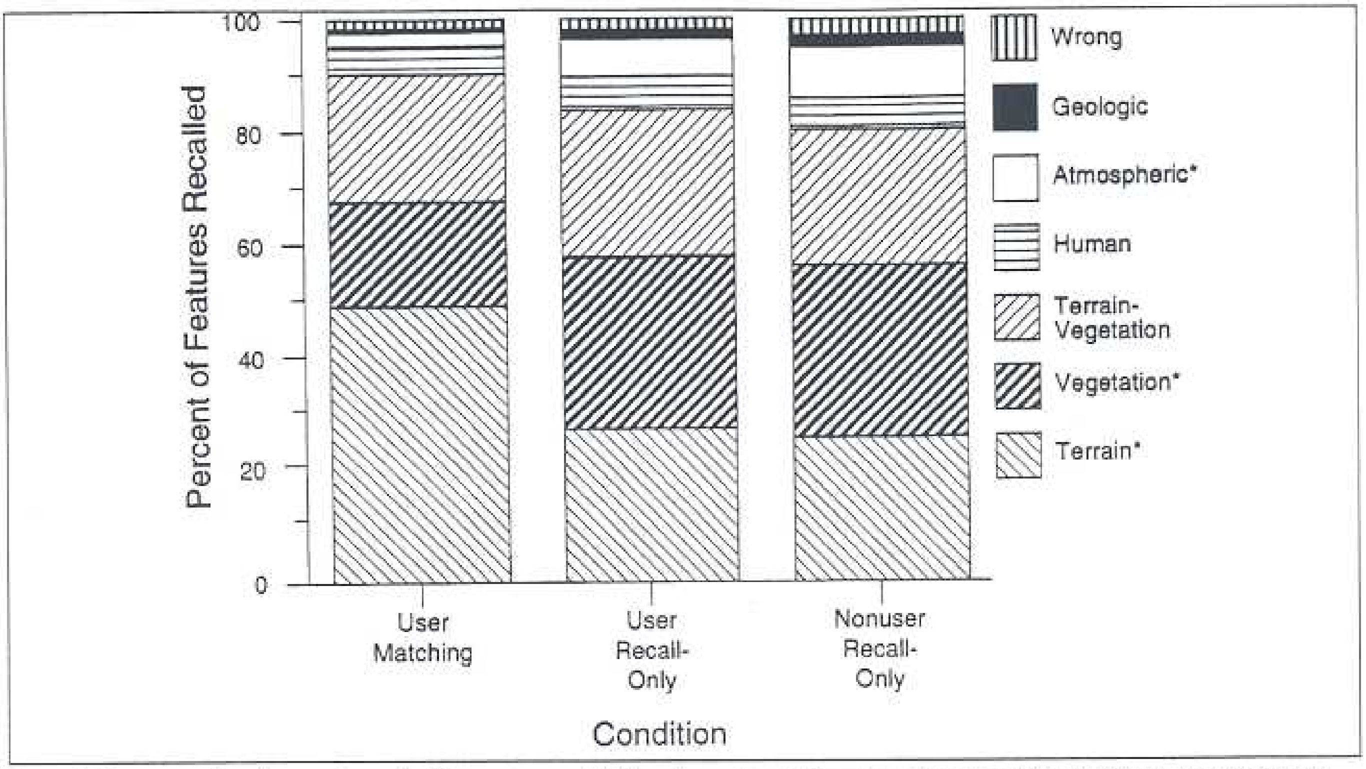

Figure 3. *Mean proportions (nontransformed) of feature-types recalled in each condition in Experiment 1 (* are significantly different across conditions).*

averaged over them. For purposes of testing significance, proportions were normalized with an arc sine transformation. Condition (*UM* user-matching, *UR* user recall-only, *NR* non-user recall-only) was a between-subjects factor.

The multivariate effect of condition was highly significant statistically, $F(30, 62) = 2.82$, $p<.0001$ (based on Wilks criterion). In order to determine the exact pattern of differences between the three conditions, two planned comparisons were conducted. A multivariate comparison of the user-matching group with the two recall-only groups was significant, $F(15, 31) = 5.85$, $p<.0001$. A comparison between the user, recall-only and non-user, recall-only groups was not significant, $F(15, 31) = 0.98$. In sum, our initial multivariate analyses indicate that the users performing a map-matching task recalled the landscapes differently than did either users or nonusers not performing such a matching task. The fact that the user recall-only subjects had experience with topographic maps did not lead them to recall the landscapes differently than did subjects who had no experience with topographic maps.

In order to determine which of the dependent variables was responsible for this pattern of differences, we next conducted a series of univariate ANOVAs on each of them. The total number of recalled features was very similar in the three conditions ($M_{UM} = 7.3, M_{UR} = 8.0, M_{NR} = 7.6$) and did not significantly differ, $F(2, 45) = 0.72$. Figure 3 depicts the mean proportions of each of the seven types of features recalled in each condition. The great majority of recalled features were terrain (30%), vegetation (32%), or terrain-vegetation combinations (22%). However, Figure 3 indicates that several of the types of features were recalled in significantly different proportions by the three groups: terrain, $F(2, 45) = 23.45$, $p<.0001$; vegetation, $F(2, 45) = 70.26$, $p<.005$; and atmospheric, $F(2, 45) = 11.07$, $p<.0001$. The remaining feature types did not significantly differ between subject groups: terrain-vegetation, human, geological, and wrong/indeterminate features. In cases of significant condition effects, Tukey's HSD tests were used to compare specific groups to each other. As suggested by Figure 3, terrain features were recalled relatively more often by the user-matching group than by the other two groups, which did not differ. The converse pattern held for the vegetation features: The user-matching group recalled significantly fewer than the other two groups, which did not differ. Atmospheric features were also recalled significantly less often by the user-matching group than by the other two groups, which again did not differ.

We next examined the proportions of each of the five types of terrain features recalled in each condition (Figure 4): hill, flat, valley, slope, and mixed. Nearly half (48%) of the recalled terrain features were hills. Another 23% were flat areas. About equal proportions were valleys (11%), slopes (10%), and mixed (8%) terrain features. However, three of the five types were recalled in significantly different proportions by the three subject groups: flat, $F(2, 45) = 11.52$, $p<.0001$; valley, $F(2, 45) = 12.29$, $p<.0001$; and slope, $F(2, 45) = 3.91$,

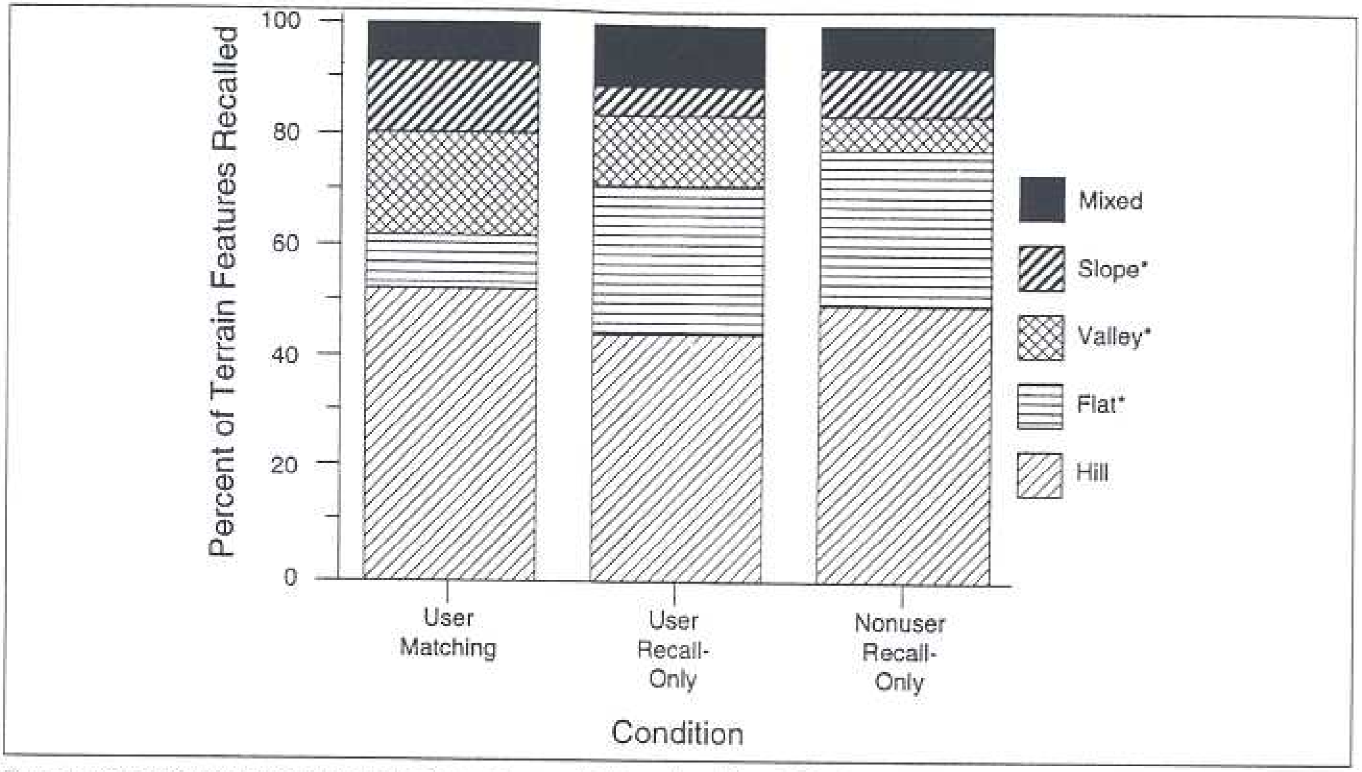

Figure 4. *Mean proportions (nontransformed) of terrain-types recalled in each condition in Experiment 1 (* are significantly different across conditions).*

$p<.05$. Hill and mixed types did not significantly differ between conditions. Contrasts indicated that flat terrain features were recalled relatively less often by the user-matching group than by the other two groups, which did not differ from each other. The two user groups did not differ in their recall of valley terrain features, but both recalled more than did the non-user group. Finally, the user-matching group recalled more slope terrain features than did the non-user group. In addition, most of the terrain and terrain-vegetation features recalled in the three conditions were single-element rather than multiple-element, though there was a marginally significant difference between the three conditions in the proportion of single-element features (M_{UM} = 81%, M_{UR} = 77%, M_{NR} = 72%), $F(2, 45) = 3.12$, $p<.06$.

Terms referring to the locations of features were then compared across conditions. The mean number of locational terms was similar in the three conditions (M_{UM} = 13.0, M_{UR} = 12.4, M_{NR} = 10.6) and did not significantly differ, $F(2, 45) = 1.68$. Most of the locational terms used by subjects were topological (only 25% metric). But this proportion significantly differed by condition, $F(2, 45) = 6.17$, $p<.005$. User-matching subjects used the highest proportion of metric terms (32%) of the three groups. User-recall subjects used 24% metric terms; non-user subjects used 20%. Only the user-matching and non-user subjects significantly differed, however. Also, most locational terms were perspective-dependent (64%), and most metric terms referred to distance rather than direction (69%). Neither of these differed significantly by condition.

Terms referring to intrinsic spatial characteristics of features (e.g., size, shape) were also examined. The mean number of spatial terms used was similar in the three subject groups (M_{UM} = 6.5, M_{UR} = 6.5, M_{NR} = 5.6) and did not significantly differ, $F(2, 45) = 0.84$. Of these, 65% referred to characteristics of terrain features rather than non-terrain features. However, subjects in the three conditions differed in the proportion of spatial terms they used that referred to terrain features, $F(2, 45) = 34.71$, $p<.0001$. User-matching subjects used a higher proportion of terrain terms (86%) than did the user-recall (56%) and non-user (53%) groups; the latter two did not differ. Apparently, user-matching subjects used more terms referring to terrain features simply because they recalled more terrain features; an index that measured the use of terrain terms as a proportion of terrain features recalled was very similar in the three conditions and did not significantly differ, $F(2, 45) = 1.65$.

Subjects in all conditions were quite accurate in their ordinal placement of features on the sketches. In total, only twenty-nine features were scored as being drawn out of place by all subjects on all sketches (about 1.6% of valid features recalled). And these were generally not severe misplacements: of the twenty-nine, twenty-six were misplaced by only a single feature on the sketch. Misplacements were evenly distributed across conditions (UM = 8, UR = 9, NR = 12).

Experience, recall, and performance on the matching task

The sixteen user-matching subjects were correct on 57.6% of the matching trials, on the average. This exceeds chance performance (33%), $t(15) = 4.22$, $p<.001$. Mean response-time (RT) was 42.31 sec/problem. RT and accuracy were correlated, though not significantly: $r(14) = .43, p<.10$; subjects who responded more slowly were more likely to be correct, a speed-accuracy tradeoff.

Correlations between task performance and experience with topographic maps were small and not significant, the largest being a correlation of .25 between days of use and number correct. However, performance correlated strongly with several aspects of scene recall. Table 2 shows that those who recalled a higher proportion of terrain features got more of the problems correct. This does not just reflect better general memory on the part of subjects performing more accurately on the matching task, as these subjects recalled fewer total features (relatively fewer vegetation, atmospheric, and geological features). Table 2 also reveals that subjects performing more accurately used both more spatial terms and a higher proportion of spatial terms referring to terrain features. In addition, slower response on the matching task was related to recall of more terrain-vegetation features but fewer vegetation and atmospheric features. Slower subjects also used more locational terms and spatial terms, and a smaller proportion of metric locational terms that referred to distance rather than direction.

DISCUSSION

The results of Experiment 1 suggest that experienced topographic-map users and novices process information from natural landscape scenes quite similarly, for the most part. However, the demand of performing a map-matching task influences several aspects of the processing and recall of landscape information. Although subjects in all conditions recalled equal numbers of landscape features, experienced map users performing a matching task recalled higher proportions of terrain features and lower proportions of vegetation and atmospheric features than did subjects who did not perform such a matching task. For subjects in the user-matching group, these terrain features were more likely to be areas with contour lines (valleys and slopes) and less likely to be flat areas without contour lines. Notably, experienced users in the recall-only group recalled a similarly higher proportion of valley terrain. Furthermore, although the three groups did not differ in the number of terms used to describe locational and spatial characteristics of features, the user-matching subjects were more likely to use metric locational terms and spatial terms describing terrain features than were the two recall-only groups (though the latter finding simply reflects the greater recall of terrain features by user-matching subjects).

User-matching subjects were able to match successfully the recalled landscapes to viewing directions depicted on the topographic maps at better than chance level. In fact, performance compared quite favorably to that found on a nonmemorial version of the same task used by Pick et al. (in press). In that study, both the scenes and the maps were simultaneously available. Excluding the New Mexico scene (Pick et al. used a different and much more difficult scene), Pick et al.'s subjects were correct on 72% of the trials, as compared to 58% in the current study. Several aspects of the scene recalls were related to more accurate performance on the matching task. Subjects who recalled a higher proportion of terrain features and lower proportions of vegetation, atmospheric, and geological features got more of the problems correct. In fact, subjects recalling fewer features of any kind actually scored higher, suggesting the greater efficiency of successful problem solvers. Also, higher-scoring subjects used more spatial terms, especially spatial terms referring to terrain features. Not surprisingly, therefore, attention to and recall of information germane to matching the landscape with the maps improved performance. Several aspects of scene recall were also associated with faster performance on the matching task (which was, however, associated with lower accuracy). Faster subjects recalled fewer combination terrain-vegetation features, and more vegetation and atmospheric features. They also used fewer locational and spatial terms and a higher proportion of distance terms than of directional location terms. These results can be interpreted most straightforwardly to suggest that those who were not as competent at the matching task performed more quickly and recalled more irrelevant information.

In sum, the nature of information recalled from natural landscape scenes varied as a function of performing a topographic matching task; it did not vary much as a function of previous training and relevant field

Table 2. Correclations of Performance on the Map-Matching Task with Feature-Types, Locational and Spatial Terms in Experiment 1

Type	Correct	RT
Total Features	-.45*	-.02
%Terrain	.69***	.15
%Vegetation	-.62***	-.51**
%Terrain-Vegetation	.12	.49**
%Human	-.22	-.07
%Atmospheric	-.43*	-.49**
%Geological	-.64***	-.32
%Wrong/Indeterminate	-.32	-.07
Terrain Features		
%Hill	.14	-.10
%Valley	-.05	.35
%Flat	-.41	-.09
%Slope	.19	.10
%Mixed	.08	-.17
Terms		
Total Locational	.19	.51**
%Metric	.13	-.17
%Perspective-dependent	-.26	-.26
%Distance[a]	-.34	-.50**
Total Spatial	.55**	.71***
%Terrain	.66***	.25

Note: $n = 16$. Correlations based on arc sine transformed proportions.

[a]Out of metric locational terms.

$^{*}p<.10$. $^{**}p<.05$ $^{***}p<.01$.

experience. What accounts for this pattern of results? As reviewed above, previous research has not examined the perception and cognition of landscape information, but has focused on the recall and recognition of maps, both planimetric and topographic. Gilhooly et al. (1988) had found differential recall of topographic-map information to be a function of topographic-map experience, echoing other research with different types of learning materials that has found specialized information-processing by experienced subjects in their domain of experience (e.g., Egan and Schwartz, 1979, with circuit diagrams). However, Gilhooly et al. did not find differential recall of planimetric-map information by novice and experienced topographic-map users. In other words, the effects of experience on information-processing was restricted to the specialized domain of the experienced subjects. In our study, topographic-map experience influenced information-processing only when the particular task at hand activated the specialized schemata developed as part of experience in that domain. Further, the correlations of performance on the matching task with aspects of scene recall is consistent with the notion that the specialized schemata activated by the task play an adaptive role in the processing of the information they are specialized to deal with. Viewing landscapes, on the other hand, cannot be considered a specialized domain; it is a domain in which nearly everyone has a great deal of experience. Without the matching task, memory for the landscapes was influenced by the real-world schemata for natural landscapes developed by novice and experienced topographic-map users alike (e.g., Mandler and Parker, 1976).

An alternative explanation for the condition differences is that the users who performed the matching task simply interpreted the recall task differently. Although instructions stressed that subjects were to recall anything and everything they remembered about the scenes, perhaps some of the user-matching subjects believed they were only supposed to recall information relevant to matching the map to the scene. Although this explanation cannot entirely be dismissed, an examination of the recalls for individual user-matching subjects argues against complete acceptance of it. No subject in this condition recalled only terrain or terrain-vegetation features, but fifteen of sixteen of them recalled a higher proportion of these features than the median proportion recalled by the other subject groups. This suggests that differences between groups were not due to a few unusual subjects. Similarly, every user-matching subject recalled some pure vegetation features, but fourteen of sixteen of them recalled a smaller proportion than the median recalled by the other subjects. And all but one user-matching subject used at least one spatial term describing a non-terrain feature (e.g., the size or shape of a tree), though none used as many as the median used by the other subjects. Thus, differences in recalled information between the three conditions apparently were not due to a restricted interpretation of the memory task by a subset of the user-matching subjects.

Aside from the experimental conditions, several aspects of the content of the information recalled from landscape scenes deserve comment. Subjects readily "parsed" the landscapes into discrete features and showed no tendency to recall them as continuous, holistic entities. Their recall of features was generally accurate, including their ordinal placement of features on the sketch maps; this is notable, given the short exposure durations and delay periods before recall. Overall, hills were clearly the most common terrain features recalled, whether by experienced or novice subjects. Valley features tended to be recalled more by the experienced map users, as mentioned above, but overall they were not commonly recalled (contra the findings of Gilhooly et al., 1988).

Metric terms were much less commonly used to describe feature locations than were topological and ordinal terms. This accords with the findings of Pick et al. (in press), though our inclusion of metric statements that were not explicitly numerical produces a higher estimate of the prevalence of metric thinking than did their research. Also, most locational terms were perspective-dependent, which makes sense in describing a landscape over which one is looking. Finally, metric locational terms most often referred to distance rather than direction, perhaps because there was a limited horizontal field-of-view in the slides but substantial depth extending away from the viewer.

Experiment 2

Experiment 2 was a study of memory for topographic maps, largely the converse of the memory study done in Experiment 1. After viewing a portion of a topographic map, subjects recalled it verbally and in a drawing. Only experienced topographic-map users were tested; we did not expect to find anything useful by asking novice subjects to interpret topographic maps. Instead of the non-user group of Experiment 1, we included a group of subjects who described and sketched the maps while looking at them, rather than working from memory. We thought this group would be useful because of the specialized nature of topographic map reading (as opposed to landscape perception) and the unusual and probably difficult nature of a free recall task involving such maps. After map description, half of the subjects who described the maps from memory also performed a matching task with landscape scenes. This design allowed us to establish how using a topographic map in a scene-matching task influences the recall of topographic-map information.

METHOD

Subjects

Another group of forty-eight subjects participated in Experiment 2, in exchange for extra credit in their psychology class. All subjects had experience using topographic maps, and the nature of their experience and training was largely similar to that of subjects in

Experiment 1. Subjects in this experiment were younger than those in Experiment 1 (mean age of 21.6 years) but still had a median of twenty-eight days (mean of sixty-four) of field experience with topographic maps (from three to 500 days). Their mean training was actually greater than subjects from Experiment 1 (2.2 on the three-point scale described above). Of the forty-eight subjects, nine were females; thirty-nine were males.

Subjects were randomly assigned to one of three groups (sixteen in each). One group, a *user view-only* group, described and sketched the maps while actually viewing them. The *user recall-only* and *user-matching* groups did the same from memory after viewing the maps. In addition, the user-matching group performed a scene-matching task after the memory task. Neither experience nor training significantly differed among the three groups.

Materials

The five maps used in Experiment 1 were also used in this experiment, along with three photos of landscape scenes taken in the field from the centre location on the maps (from the same locations as the photos in Experiment 1, but in different directions). Subjects sketched what they recalled of the maps on recall circles. These were blank circular outlines of the stimulus maps with the distance scale and contour interval marked in the corner, and the subject's ostensible location marked by a dot in the centre. In the user-matching condition, another blank map outline similar to the recall circles was provided with a single arrow emanating from the centre location, pointing in the direction in which one of the three scene photos had been taken (arrow circles). The scene photos in the user-matching condition were projected on a back-projection screen in a darkened room, as in Experiment 1. A tape recorder was again used to record verbal recalls of the maps, and a stopwatch was used to time the various phases of the procedure.

Procedure

Subjects were again tested individually, beginning with a practice map. The memory and recall instructions for the maps were similar to those given for the scenes in Experiment 1. That is, a viewing period was followed by a delay, and then a verbal description and a sketch drawing. Subjects were told to describe "landscape features" on the maps rather than specific contour lines. As in Experiment 1, the maps were presented in different random orders for each subject within a condition, and the orders were counterbalanced across conditions.

However, because pilot research indicated that memorizing and recalling the maps was more difficult than memorizing and recalling landscape scenes, the timings of several aspects of this experiment were modified, compared to those of Experiment 1. The viewing period was longer, either ninety or 180 seconds. A thirty-second delay period was used after the maps were studied, rather than the three-minute delay in Experiment 1. Finally, subjects were given three minutes rather than two minutes to describe and sketch the maps during the recall period. Subjects in the view-only condition viewed the maps in the same way as did subjects in the recall conditions; after the study period, the map was not removed, but was described while subjects viewed it.

After completing recall of a given map, subjects in the user-matching condition performed a scene-matching task that required them to match a direction from the recalled maps with one of three landscape scenes photographed at the location in the centre of the map. An arrow-circle was given to them. A sequence of three landscape scenes was shown to them. They had control of the slide projector, and could go back and forth among the three scenes as often as they wanted. Their task was the converse of the map-matching task used in Experiment 1: to pick which of the three scenes they thought was photographed from the direction indicated by the arrow on the arrow-circle. Subjects stated which scene they thought corresponded to the direction on the map. Both speed and accuracy of response were again stressed and recorded.

Map Recall Coding

The verbal descriptions and sketches were coded as in Experiment 1. Although the coding system for the recalled maps was broadly similar to that developed for the recalled scenes, several aspects were different because of differences in the types of information provided by a map and by a scene. In the case of the maps, all features were terrain features. They were coded into terrain types, much as in Experiment 1: (1) *hill*, (2) *flat*, (3) *valley*, (4) *slope*, (5) *mixed*, (6) *water*, (7) *other* (mostly contour lines and spot elevations) and (8) *wrong*/indeterminate. Also, a record was kept of whether subjects described their self-location on the map as a feature.

Terms or phrases that explicitly described spatial properties of features were coded as in Experiment 1 (locational and spatial terms). Spatial terms, describing intrinsic spatial characteristics of features, were classified in somewhat greater detail than in Experiment 1. No distinction between terrain and non-terrain terms was made, given that all terms referred to terrain features. However, distinctions were made among (1) size or number, (2) shape, (3) slope, and (4) altitude. Slope and altitude were further coded as metric or topological. Coding reliability was again satisfactory (e.g., 89% agreement on the number of features, 86% on the number of hill features, and 76% on the number of valley features).

RESULTS

We again began by examining all dependent variables simultaneously in a MANOVA in order to determine the overall pattern of differences between the subject conditions. This included the proportions of described terrain types, locational terms, and spatial terms used. Analyses were averaged over the five maps and two viewing times, and proportions were normalized with the arc sine transformation for the purpose of significance testing. Subject condition (*UM* user-matching, *UR* user recall-only, *UV* user view-only) again served as a between-subjects factor.

Unlike the results of Experiment 1, the multivariate effect of condition failed to reach significance, $F(28, 62) = 0.77$ (Wilks criterion). Neither multivariate planned comparison reached significance: comparison of the user-matching group with the recall and view-only groups, $F(14, 31) = 0.54$; comparison of the recall-only group with the view-only group, $F(14, 31) = 1.05$. None of the univariate tests underlying these multivariate comparisons was statistically significant. Our initial multivariate analyses thus indicate no differences between the map descriptions of the three groups. Performing the scene-matching task did not influence map recall, and descriptions of the maps from memory were not discernibly different from descriptions done while actually looking at the maps.

Given this lack of differences, no further analyses comparing the conditions were conducted. Averaged over conditions, the total number of features described was 6.68. Proportions of described terrain features were: hill (36%), valley (15%), slope (13%), flat (9%), mixed (8%), water (6%), other (5%), wrong/indeterminate (8%). As in Experiment 1, more than twice as many hill-type terrain features were described as any other terrain feature. On about half of the trials, subjects described a feature at their location on the map. Forty-three percent of the terrain features were classified as multiple-element (compared to 33% in Experiment 1).

The mean number of locational terms used in the map descriptions was somewhat less than the number used to describe the scenes in Experiment 1 (7.0 vs. 12.0) but were again primarily topological (only 15% metric). A smaller proportion (48%) of locational terms was perspective-dependent than in Experiment 1 (64%); most metric locational terms again referred to distance rather than direction (71%). The mean number of spatial terms used to describe intrinsic characteristics of map features was somewhat higher than the number used to describe scene features in Experiment 1 (8.7 vs. 6.2), probably because of the much larger number of references to slope and altitude with the maps (63% of spatial terms). Of these "vertical" terms, a high proportion were metric (55%) rather than topological — a much higher proportion than was found in either experiment for locational terms referring to map or scene features. Finally, subjects were again quite accurate in their ordinal placement of features on the sketches. Only 24 features were judged to be drawn out of place by all subjects on all sketches. This was about 1.5% of valid features described.

Experience, recall, and performance on the matching task

The sixteen user-matching subjects were correct on 42.4% of the matching trials, on average. This exceeds chance performance, but not significantly, $t(15) = 1.40$. The matching task was clearly difficult to perform, at least in the present memorial version. Mean RT was 34.7 sec/problem. Performance on the matching task was correlated with experience and scene recall. Accuracy was greater for subjects having more days of field use with topographic maps, $r(14) = .50, p<.05$. Also, subjects with more training were faster at the matching task, $r(14) = -.59, p<.05$. RT and accuracy were not significantly correlated, $r(14) = .15$, as they were in Experiment 1.

As shown in Table 3, there was a strong tendency for subjects performing more accurately to recall a higher proportion of valley features, though it was not significant for a sample size of sixteen. There were also tendencies (that were not significant) for those performing more quickly to recall more total features, fewer hill features, and more flat and slope features. There were no robust correlations between performance and the use of locational terms and spatial terms.

Although the performance of a matching task did not influence recall of the maps, we wanted to determine if self-reported experience with topographic maps was related to aspects of the map descriptions. Because we did not include a group of novice subjects in this experiment, as we had in Experiment 1, we could not examine the relationship of map experience to the map descriptions by comparing mean performance across conditions. Instead we examined correlations of training and days of field use with various aspects of the map descriptions. As shown in Table 4, subjects with more training described a significantly higher proportion of valley features, a finding which mirrors the condition differences found in Experiment 1. Subjects with more training also described a higher proportion of water features, a lower proportion of perspective-dependent locational terms, and a lower

Table 3 Correlations of Performance on Scene-Matching Task with Terrain-Types, Locational and Spatial Terms in Experiment 2

Features	Correct	RT
Total Features	.07	-.45
%Hill	.01	.48*
%Valley	.36	.08
%Flat	-.02	-.42*
%Slope	.09	-.42*
%Mixed	.12	.32
%Other	-.11	-.23
%Wrong/Indeterminate	-.25	.22
Terms		
Total Locational	-.06	-.17
%Metric	.04	-.29
%Perspective-dependent	-.01	-.10
%Distance[a]	.33	-.02
Total Spatial	.28	-.14
%Vertical	.32	.13
%Metric Vertical[b]	.05	-.18

Note. n = 16. Correlations based on arc sine transformed proportions.
[a]Out of metric locational terms. [b]Out of vertical spatial terms.
*$p<.10$.

Table 4 Correlations of Training and Field Experience with Terrain-Types, Locational and Spatial Terms in Experiment 2

Features	Training	Experience
Total Features	.15	.11
%Hill	-.18	-.06
%Valley	.39***	.22
%Flat	.06	-.14
%Slope	-.08	.16
%Mixed	.25	-.08
%Other	-.15	-.08
%Wrong/Indeterminate	-.19	-.16
Terms		
Total Locational	-.05	.10
%Metric	-.03	.20
%Perspective-dependent	-.34**	-.05
%Distance[a]	-.19	-.06
Total Spatial	.03	.12
%Vertical	-.34**	.00
%Metric Vertical[b]	.13	.32**

Note. n = 48. Correlations based on arc sine transformed proportions.
[a]Out of metric locational terms. [b]Out of vertical spatial terms.
**$p<.05$. ***$p<.01$.

proportion of vertical spatial terms. Subjects having more days of field experience with topographic maps used a higher proportion of metric vertical terms and a marginally higher proportion of total metric terms (combining metric locational terms and metric vertical terms).

DISCUSSION

The results of Experiment 2 contrast sharply with those of Experiment 1. In the first experiment, the performance of a landscape-map matching task influenced processing and recall of landscape scenes, but in the second, the performance of such a task did not influence processing and recall of topographic-map information. The number of recalled map features, the types of features, and the use of locational and spatial terms did not significantly differ as a result of the performance of this task. Furthermore, the amount and type of map information described in the two memory conditions was quite similar to that described in the view-only condition (the latter subjects described the maps while looking at them). This suggests that the recall measures largely reflect the perceptual processes of experienced map users rather than memorial processes that are not part of map perception (e.g., forgetting or distortion).

The lack of a difference between subjects who did and did not perform the matching task suggests that such a task did not instigate any specialized knowledge schemata that were not already instigated by simply viewing the map. In Experiment 1, performing a map-matching task modified the processing of landscape information. As discussed above, viewing landscapes is a task at which everyone has a great deal of experience, regardless of training with topographic maps. The actual performance of a map-matching task was required to instigate specialized knowledge schemata. Conversely, topographic-map reading is not a general skill — it apparently instigates specialized knowledge even when no specific task is performed with the maps.

It is possible, however, that the task was simply too difficult, and did not instigate any processing differences that could occur as a function of such a task. The memorial version of the scene-matching task was apparently quite difficult; the user-matching subjects did not perform significantly better than chance levels. In a nonmemorial version of the same scene-matching task, Pick et al. (in press) found that it was somewhat more difficult than the map-matching task, though their subjects did perform significantly better than chance at 59% correct. The memorial version used in the present experiment was solved correctly on only 42% of the trials. Consistent with this explanation for the lack of differences, there was not much relationship in the present experiment between aspects of the map recalls and performance on the matching task (contra the relationships with the matching task found in Experiment 1). A floor effect on performance, as well as any loss of effort or motivation engendered by an insoluble task, could account for this. Notably, as in the first experiment, there was a suggestion of greater accuracy by those subjects who recalled more valley-type terrain features.

However, we did find relationships between topographic-map experience and aspects of map recall, as has been found in some previous research (Gilhooly et al., 1988). Subjects with more training described more valley terrain-features, and used fewer perspective-dependent locational terms and vertical spatial terms. Those with more field experience used a higher proportion of metric rather than nonmetric vertical terms. Specialized knowledge schemata involving topographic maps do appear to develop with experience in the domain.

Aside from the experimental conditions, subjects again readily parsed the maps into discrete features — they did not show a tendency to recall the maps as continuous, holistic entities. Map recall was generally accurate, as was landscape recall in Experiment 1. Hills were again the most common terrain features recalled (as mentioned above, however, subjects with more training mentioned relatively more valley features). Metric locational terms were again used much less commonly than were nonmetric terms. However, most of the spatial terms used to describe vertical characteristics of terrain features were metric, which makes sense given that this information is so explicitly depicted on topographic maps. Finally, there was a somewhat lesser tendency to use perspective-dependent locational terms in the present experiment than in the first experiment. Even though subjects were asked to imagine the centre of the maps as their locations, viewer location is not an intrinsic part of a map designed with an orthographic perspective, as it is of a landscape view.

General Discussion

The two experiments reported above examine the recall of terrain and non-terrain information from natural landscapes and topographic maps. As such, they contribute to the literature on the perceptual and cognitive processing of maps and environments. In Experiment 1, the nature of information recalled from photos of landscape scenes was influenced by the performance of a task that required matching the landscapes to topographic maps; however, it did not differ much as a function of whether subjects were experienced or novice topographic-map users. Conversely, in Experiment 2, information recalled from topographic maps was not influenced by the performance of a task that required matching the maps to photos of landscape scenes. However, map recall did vary to some extent with the amount of training and field experience subjects had had with topographic maps.

This pattern of results is suggestive of the specialized knowledge that develops as part of experience with topographic maps. However, this knowledge will only be expressed in the context of a task that implicitly or explicitly calls for it. In Experiment 1, recall of landscapes did not vary as a function of prior map experience because viewing and recalling landscapes does not involve topographic-map knowledge per se — it does involve the sort of nonspecialized knowledge that anyone who looks at landscapes may be expected to bring to the task. Only the performance of the matching task brought out a specialized way of viewing and thinking about landscapes. Experiment 2 suggests, however, that simply viewing topographic maps will implicitly activate the specialized knowledge developed as part of experience in that domain: the performance of a scene-matching task was not required to instigate that knowledge.

This conclusion has clear implications for research on individual differences and expertise. Crampton (1992), for instance, reported some interesting research on problem-solving by expert and novice orienteers on a wayfinding task involving orienteering maps. He found several differences between the two groups in their attended information, problem-solving strategies, etc. These differences should not be generalized too far, however. They were found in the context of a specialized task in which the experts were highly experienced. However, we do not expect this specialized expertise to extend to more general, everyday situations of wayfinding, — situations with which all people presumably have a great deal of experience.

What is the nature of the specialized knowledge developed as part of experience with topographic maps? Most obvious is the attention to landscape information that is useful for matching to topographic maps (terrain features and their characteristics) rather than to landscape information not of much use (vegetation, atmosphere and precipitation, sand). This specialized knowledge is apparently characterized by relatively greater attention to particular types of terrain features: slopes and valleys rather than hills and flat areas. However, hills are the most common terrain feature appearing in the data across all subject groups. Although the use of metric spatial knowledge was not great by any of the subject groups in the two experiments, there was evidence for the greater use of metric locational knowledge in Experiment 1, and of metric vertical knowledge in Experiment 2, as part of the specialized knowledge of experienced topographic-map users. The results of both experiments suggest that the nature of this specialized knowledge and processing has implications for the effective use of topographic maps in certain tasks.

The use of a recall paradigm appears to be a fruitful approach to unlocking the cognitive processes of people using maps. Other, more structured, memory paradigms would also prove useful: Priming (McNamara, Ratcliff, and McKoon, 1984) and the ordered-tree algorithm (Hirtle and Jonides, 1985) are two promising possibilities. An examination of recognition memory as a function of systematic distortions in both metric and topological properties of terrain features would be an efficient way of addressing the issue of what type of spatial knowledge is important during map use. It might be interesting to perform more intensive case studies of people who are highly trained to memorize topographic maps (e.g., because of special military training). Especially useful would be more investigations of map use *in situ;* for example, while actually navigating through natural terrain. Finally, future research should include computerized dynamic spatial displays (vehicle navigation systems, virtual displays, etc.), soon to be widely available.

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Résumé Mémoire de rappel pour les cartes topographiques et le terrain naturel: les effets de l'expérience et de l'exécution de tâches. On a effectué deux expériences afin d'examiner le rappel d'information à partir de paysages naturels et de cartes topographiques. Dans l'expérience no 1, la nature de l'information rappelée de photographies de scènes paysagères par des usagers de cartes topographiques, expérimentés et novices, a été influencée par l'exécution de correspondance cartographique mais n'a pas beaucoup varié en fonction de l'expérience avec des cartes topographiques. Dans l'expérience no 2, la nature de l'information rappelée des cartes topographiques par des usagers expérimentés n'était pas influencée par l'exécution de correspondence de scènes, mais a plutôt varié en fonction de l'expérience cartographique. On explique les résultats en se référant aux contextes dans lesquels on aura utilisé une connaissance spécialisée qui se développe avec expérience de l'utilisation des cartes topographiques. On discute des caractéristiques de cette connaissance spécialisée ainsi que des propositions de recherche supplémentaire sur le traitement d'information qui se produit en cours d'utilisation de cartes.

Zusammenfassung Erinnerung nach topographischen Karten und natürlichem Gelände: der Einfluss von Erfahrung und von der Leistung bei Zuordnungsaufgaben Zwei Experimente wurden ausgeführt, um die Erinnerung von Information zu untersuchen, die aus der Betrachtung von natürliche. Geländeformen und von topographischen Karten stammt. Am Experiment 1 beteiligten sich Experten und Neulinge im Lesen topographischer Karten. Sie musten Information ins Gedächtnis zurückrufen, die sie beim Studium von Geländephotographien gewonnen hatten. Dabei zeigte die Art der zurückgerufenen Information den Einfluss der Leistung bei der Aufgabe, ein Kartenbild einer Geländeform zuzuordnen aber sie variierte nicht sehr in Abhängigkeit von der Erfahrung mit topographischen Karten. Im Experiment 2 war die Art der aus topographischen Karten gewonnenen Information, an die sich erfahrene Leser solcher Karten erinnerten, nicht beeinflusst von der Leistung bei der Aufgabe, eine photographierte Szene einem Kartenbild zuzuordnen, aber sie variierte zum Teil in Abhängigkeit von der Erfahrung mit Karten. Die Ergebnisse werden erklärt unter Hinweis auf die Zusammenhänge, in denen spezialisierte Kenntnisse, die als Teil der Erfahrung mit topographischen Karten entstehen, aktiviert werden.Charakteristika dieser spezialisierten Kenntnisse werden diskutiert. Endlich werden Vorschläge gemacht für die weitere Erforschung der Informationsverarbeitung, die bei der Kartennutzung stattfindet.

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