Map Perspective and the Learning of Text

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Abstract:

In two studies, undergraduates learned a map of the city of Rome in either a flat survey map or a one-point perspective format. The perspective map lead to greater feature recall in the first study and to better memory for a related text when features were correctly located in the second study. Both studies suggest that map scanning patterns may differ depending on the learner's point of view.

Article:

People remember more from reading a text when they previously have viewed a map related to the text content (e.g., Kulhavy & Stock, in press). Map-text facilitation occurs because the two types of stimuli are encoded into different memory stores. Visually based map information is deposited in a non-verbal store, and verbally based text information becomes part of the propositional network in a verbal memory store (Paivio, 1986). Associative links between the verbal and non-verbal codes allow map information to cue retrieval of related text. Cross-code cuing is the reason maps facilitate recall of text.

People encode two types of information from a map. The first type is termed "feature" information, and consists of individual point markers and locations on the map. Our definition of feature information also includes variables such as color, form and size. The second type is "structural" information and refers to the spatial framework within which the map features are embedded. Structural information includes the geometric and metric relations between features and the border paths and lines that serve as reference points for features.

Because structural information is present, people can form an intact image of the map which possesses quasi-pictorial qualities, and can be processed as units in working memory (Kulhavy, Stock, Verdi, Rittschof, & Savenye, 1993). Since the map is encoded as an intact unit, it can reside in working memory without using all of the resources available. Hence, the remaining resources can be used for retrieving text information related to the map features.

Research in the map-text tradition has generally used reference and thematic maps that depict territory in the "plan view" format of traditional cartography. Recent developments in geographic information technology and in the capabilities of the personal computer make changes in map perspective a likely candidate for use in instruction. Hence, in the current studies we were interested in whether changes in the linear perspective of the map would influence recall of either the map itself or the related text. The one-point perspective used here renders the map surface as a plane receding in space, with terrain features represented as they might appear to the eye.

A one-point perspective increases map dimensionality and should provide a richer encoding base for structural relations among features and reference points. The presence of additional structural information in the map image should increase both map recall and the retrieval of related text facts.

STUDY 1

Method

Design and subjects. There was one between-subjects factor with two levels. Subjects responded to either a flat survey map (plan map), or to a one-point perspective (perspective map) of the same map space. The subjects were 54 undergraduates who received course credit for participation. Subject were randomly assigned, 27 to each between-subjects group, based on the Order in which they appeared for the experiment. One subject was dropped from the plan map group for failing to follow instructions.

Materials. The plan stimulus map was a bas-relief plan view of ancient Rome set within a rectangular border. The map contained 20 target features, with each feature represented by a small square and a verbal label naming it. The map also included a wall which served as a visual organizer to aid subjects in map reconstruction during the recall phase.

Using a personal computer, the plan map was scanned and digitally reconfigured into a one-point perspective of the identical terrain so that a vertical angle of about 45° was formed between the tangent of the picture plane and the apparent map surface. Both maps were printed in black ink on a 21 x 35-cm sheet of white paper, with the plan map in vertical format and the perspective map in horizontal format. This was done to accommodate the "flattened" distortion of the later resulting from foreshortening. Additionally, the perspective map was enlarged slightly so that the overall stimulus area of the two maps was roughly equivalent. The perspective map is displayed in Fig. 1.

Procedure. Subjects participated in groups of size six to eight, with each group housed in

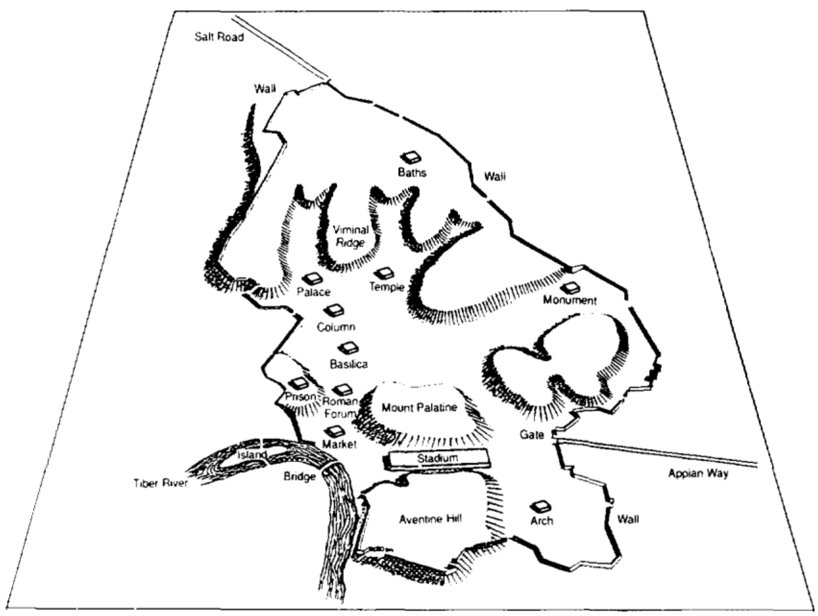

FIG. 1. Perspective map used in both studies.

a different classroom. Subjects were seated as far apart as possible and received a packet of materials from a randomly shuffled stack which assigned them to the plan or perspective condition. Next, subjects were instructed to take out the materials from 1he first envelope and read the instruction sheet silently while the experimenter read it aloud. Subjects were told to write a description of the map in enough detail so that a friend could visualize the map as well as they could. The instructions asked subjects to describe each feature, and to include locations and intramap relationships as often as possible. Subjects were allowed 20 min to complete their description and were then told to replace their materials back in the original envelope.

After a 1-min rest period, subjects opened the second envelope and removed an outline of the map they had just described. The outline contained both borders and wall, but all feature information was removed. Subjects were told to reconstruct the map by placing an "x" where each feature was located, and printing the feature's label below it. They were also instructed to sequentially place a letter from the alphabet next to each feature in order to help keep track of 1he order in which they were reconstructed. They were given 10 min to complete the reconstruction task.

Results

The map reconstructions were scored for both the number of feature names written on the map reconstruction, and for the number of features correctly located. Location scoring involved placing a transparency of the map over each reconstruction and counting a feature as accurately located if it overlapped at least 50% with the original location on the map. The reconstructions were scored by one of the authors and a sample o five protocols were independently scored by a second judge. The inter- rater agreement was 84% across both groups.

All statistical tests reported below were evaluated at $p < .05$. The means and standard deviations for features recalled and for features located are reported in Table 1. Students viewing the one-point perspective map recalled significantly more features, $F(1, 51) = 8.45$, $MS_e = 11.03$, and were able to locate more features correctly on the reconstruction, $F(1, 51) = 15.59$, $MS_e = 11.23$. Memory for features was facilitated by viewing the perspective map.

An examination of map reconstruction patterns using the order of feature placement, suggested that viewers of the plan map were more likely to create their reconstruction in the typical fashion from top-to-bottom (e.g., Winn, *1991).* Alternately, subjects seeing the perspective map showed a tendency to construct their map beginning with the frontal plane (bottom of the map) and work upward. Hence, there is some indication that a one-point perspective influences the way in which a map is remembered by the viewer. Correlations between the orders in which features were mentioned in the written protocols and recalled on the reconstructions did not differ from zero.

STUDY 2

Method

Design and subjects. Type of map formed a between-subjects variable with three levels. One group saw the same plan map, a second group the perspective map, and a third group (control) saw the plan map with all feature information removed. Each group heard and recalled a map related fact text following map study.

TABLE 1

MEANS AND STANDARD DEVIATIONS FOR RECALL AND PLACEMENT: STUDIES 1 AND 2

	Map			
	Plan		Perspective	
Variable	*M*	*SD*	*M*	*SD*
Study 1				
Map features realled	11.62	3.86	14.27	2.80
Map features located	5.37	2.88	8.96	3.22
Study 2[a]				
Map features recalled	15.07	3.81	13.54	4.75
Map features located	5.78	3.51	7.25	4.29
Text features recalled	13.89	3.48	11.68	4.54
Text facts recalled	8.03	4.06	7.92	5.54

[a] Mean recall for the control group was 4.87 (*SD* = 2.87) for feature names, and 4.65 (*SD* = 2.19) for text facts.

The subjects were 79 new undergraduates who participated for course credit and were randomly assigned to one of the three conditions. Three subjects were dropped from the analysis for failure to follow instructions. The final ns were, plan (27), perspective (28), and control (21).

Materials. The plan and perspective maps were identical to those used in Study 1. The control group received the plan map with all features removed except the "wall" which was labeled in the same three places as the other two maps.

The fact tex1 consisted of a 365-word narrative titled "The City of Rome" (this text can be found in Kulhavy, Stock, Verdi, Rittschof, & Savenye, 1993). The text consisted of 26 sentences, six of which were fillers to make the passage sensible, and 20 of which described a true fact about each of the 20 landmarks on the map. The 20 paired feature-fact units were mentioned only once in the text. The labeled wall was not mentioned in the text. The passage was tape recorded in a female voice at a rate of about 100 words/min for use in the study.

Procedure. The subjects participated in groups of size six to eight and were seated as far apart as possible in a regular college classroom to preclude peeking. Once seated, each subject was given a packet of three envelopes from a randomly shuffled stack which assigned them tO one of the three conditions. Subjects then took out the materials from the first packet and read the instructiOns silently while the experimenter read them aloud. Subjects were told that they would study a map for 4.5 min and that learning the informatiOn on the map would help them to learn text material studied later. Subjects then studied the map and a1 the end of the 4.5-min period replaced it in the first envelope. They were then instructed to listen to the city Of Rome tape and to learn the information using what they remembered of the map to assist them. The tape was played twice with a 1-min rest interval between playings, during which instructions to use the map to help learn the text were repeated.

When the las1 playing of the tape was completed subjects opened their second envelope. removed 1wo sheets of blank paper and were given 10 min to write down everything they could remember from the text. At the end of 10 min the recall protocols were returned to the envelope and subjects Opened the third envelope which contained an outline of the map they originally studied, including the labeled wall. Subjects were asked to reconstruct the map by placing an "x" at the feature location and writing the feature name next to it. Again, subjects were instructed to place sequential alphabetic letters next 1o features as they placed them on the map. Subjects were allowed 10 min to complete their reconstruction.

Results

The text recalls were scored using a gist criterion, where facts were scored as correct if their substance was present in the response. The map reconstructions were scored for both presence and location of features in a manner identical to Study 1. Both text recalls and map reconstructions were scored by four judges, with a random sample of five complete protocols from each condition independently scored by a fifth judge. There was a 98% agreement between scorings.

All statistical tests were evaluated at $p < .05$. The means and standard deviations for fact recall, and both feature recall and location are displayed in the lower half of Table L We used a series of planned contrasts to test predictions related to recall of text facts. The only comparison to reach significance was between the two groups seeing the map and the control group who viewed the outline $F(1, 75) = 10.32$, $MS_e = 18.32$. This result replicates previous data on map-text facilitation. The difference between the plan and perspective groups on fact recall was not significant.

As expected, the two map groups also placed more features on the map, $F(l, 75) = 61.32$, $MS_e = 18.32$ (the controls heard the feature names, but never saw them on the map).

In order to relate fact recall to the structural accuracy of map reconstruction, we calculated two sets of conditional probabilities of the form *P* (fact recalled feature recalled) and *P* (fact recalled feature correctly located) for the plan and perspective groups. The probabilities relating fact recall to features remembered (without regard to location) did not differ significantly between the two map groups. The mean probabilities were *.50* and *.51* for the plan and perspective conditions, respectively. However, when fact recall was conditionalized on accurately located features, the perspective group *(M = .35)* significantly outperformed the plan group *(M = .28), F(1, 54) = 39.00*, $MS_e = .05$. The more accurately subjects in the perspective group were able to locate a feature on their reconstructions, the more likely they were to remember the associated fact.

Study 1 suggests that scanning patterns may differ as a function of perspective. In order to gain some measure of this difference, we calculated the mean order in which the first seven features were placed on the map reconstructions, taking this value as an indication of the order in which features were initially learned. In this case, the smaller the value, the earlier the placement on the reconstruction. For the plan map the feature placement mean for the top half was *3.7* and for the bottom half *5.0.* This pattern indicates a clear top-to-bottom placement pattern. For the perspective map the top mean was 4.2 and the bottom 4.5, suggesting less differentiation in feature placement.

GENERAL DISCUSSION

Taken overall, the data from the two studies indicate that Perspective influences both how people learn a map and how they are able to use what they have learned. When subjects' intent was to describe the map accurately, those in the perspective group remembered more features and their locations—although no such difference existed when the intent was to use the map to learn text. What is remembered from the map depends on the intent of the viewer (Kulhavy & Stock, in press). When people described a perspective map they are able to recall more of its content, probably because of the additional structural information such maps contain.

Both plan and perspective maps facilitated recall of text information compared to the outline control, replicating the numerous studies done with such stimuli. However, the perspective group recalled significantly more text facts that were related to accurately located features. Kulhavy and Stock (in press) have proposed that memory for feature location is an index of the structural accuracy of the map image. Hence, memory for structure increased fact recall more for the perspective than for the plan maps. This finding suggests that it is the quality of structural information that is important for text retrieval.

There is some indication in these studies that how people remember a map is influenced by their point of view. According to theorists such as Winn (1991), maps are read top-to-bottom and left to right, much as we read a text. This pattern appears to hold for the plan map used here. However, if one accepts the map reconstruction data as an index of initial learning, subjects in the perspective group were less likely to use the top-to-bottom strategy. In this case subjects may have given the bottom of the map, now functionally the "front" of the display, greater processing precedence. The data suggest that how maps are learned depend to some degree on perspeetive and that universal statements regarding topto-bottom spatial processing may need careful consideration.

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