Conjoint Influence of Maps and Auded Prose on Children's Retrieval of Instruction

By: James M. Webb, Ellen D. Saltz, Michael T. McCarthy, and William A. Kealy

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Abstract:
Fifth-grade students studied a map of a fictitious island while twice listening to a related narrative containing target feature and nonfeature items. The students were cued by varying iconic and verbal stimuli in four map cue conditions; they received immediate and delayed tests to recall text items, map features, and feature locations. The students were also required to rate their confidence in each response. Students remembered more text features and were more confident of their responses when cued by icons plus labels and by icons only. Students in these groups also recalled more map features and their locations on a map reconstruction task. Memory for feature information and pictorial retrieval cues appeared to activate memory for nonfeature information contained in the text.

Article:
Individuals remember more information from a narrative when they are provided with a spatially organized figure depicting features related to the narrative (Dean & Kulhavy, 1981; Kulhavy, Woodard, Haygood, & Webb, 1993). Recall and recognition of that information is facilitated when people create or process maps associated with a prose passage that is either read or heard (Abel & Kulhavy, 1986, 1989; Peterson, Kulhavy, Stock, & Pridemore, 1991; Schwartz & Kulhavy, 1981; Webb, Thornton, Hancock, & McCarthy, 1992). The locus of facilitation appears to be centered around items that semantically relate map features to a text and is a function of features distributed across the map's surface (Dean & Kulhavy, 1981; Kulhavy, Lee, & Caterino, 1985; Peterson et al., 1991).

An explanation that is often cited for this productive relationship between maps and text is the conjoint retention hypothesis (e.g., Kulhavy et al., 1985; Kulhavy, Stock, Peterson, Pridemore, & Klein, 1992; Kulhavy et al., 1993; Webb et al., 1992). Conjoint retention is a derivation of dual coding theory (Paivio, 1986) that postulates that semantic propositions are represented in memory as verbal-linguistic information, and images are represented as perceptual-spatial information with a privileged status in terms of the access and retrieval value of their images (Abel & Kulhavy, 1989; Kulhavy et al., 1992, 1993; Peterson et al., 1991). These two codes are assumed to be interconnected and capable of providing retrieval cues for each type of memory representation (Paivio, 1986). Further, it is assumed that a map is stored as an intact, perceptual-spatial unit that maintains some of its depicted spatial relations among features, thereby providing an economical representation of the map in working memory (Kosslyn, Ball, & Reiser, 1978; Larkin & Simon, 1987).

The conjoint retention hypothesis maintains that a learner can use spatial and verbal representations simultaneously to retrieve target information during a recall task. For example, a learner studies a map and reads or hears a related narrative, following which he or she is presented with a series of test items that are derived from the narrative. At recall, retrieval cues initiate a search of semantic memory. If a correct response is located, the search activity is terminated. If target information is not located in an initial search, a representation of the map is activated in working memory, and the encoded features of the representation provide second-order or second stratum cues to the semantic memory networks (Kulhavy, Caterino, & Melchiori, 1989; Kulhavy, Thornton, Hancock, & Webb, 1990; Peterson et al., 1991; Webb et al., 1992). Thus, the probability of recalling the target information increases as a function of the learner's use of stimuli on the map as additional retrieval cues.

Evidence for conjoint retention exists in studies in which both the spatial quality of a map and its relation to a related text have been separately varied. In a classic experiment of this type, Schwartz and Kulhavy (1981) presented an outline of a map with its features either distributed across its surface or displayed as a list next to the outline. Experimental conditions differed only in the spatial arrangement of features on the map for each group. An accompanying text contained information that was, or was not, related to the map features. Their findings revealed that individuals who viewed the spatially distributed map correctly recalled a greater percentage of items contained in the text that were semantically related to the map features. In subsequent replications of the facilitative effects of a spatially distributed map on feature-related text (see Able & Kulhavy, 1986, 1989; Kulhavy et al., 1993), map features were found to be used often as cues for accessing related verbal material under conditions in which the map could be represented as an intact image.

Further evidence indicated that conditional probabilities of recalling text information, given recall of the associated feature, is significantly higher for distributed map groups in every case where this measure has been calculated (e.g., Able & Kulhavy, 1989; Kulhavy et al., 1989; Schwartz & Kulhavy, 1981; Webb et al., 1992). This consistent relationship indicates a direct link between specific map features and the associated text-based information.

In addition, when the access/retrieval values (i.e., mimeticism) of map features are varied, the values appear to be directly related to the degree to which a feature represents an object it portrays (Robinson & Petchenik, 1976). For example, a map feature (icon) exists on a continuum ranging from a high value or highly mimetic (e.g., a church is drawn to look like a church) to a low value or arbitrary (e.g., a church is represented by an X). The more mimetic the icons, the more available they seem to be in memory as second stratum cues for retrieval of related prose. Because the level of mimeticism is often equated with concreteness, higher mimeticism typically produces more memorable images and higher probabilities that the icon will be available for accessing related verbal information (Abel & Kulhavy, 1989; Robinson & Petchenik, 1976). The assumption is that the more mimetic the icons on a map, the better the conjoint recall of associated information from verbal memory.

We designed the current study to systematically examine the retrieval mechanisms inherent in the process of selecting cues for retrieval and to explore the retrieval assumption component of the conjoint retention theory. By having subjects study a map of an island with both mimetic icons and verbal labels for feature items while listening to a narrative about the island and its inhabitants, we created an opportunity for subjects to encode the map in either a semantic or image code. Given the assumption that encoded verbal content is best remembered when it is tied to an intact, spatial representation, we expected subjects provided with a map containing spatially distributed labels to be able to remember a high number of features that can be used as second stratum cues for retrieval of information contained in the narrative. Therefore, it should be possible to cue recall with labels or icons.

We predicted that the labels-only and icons-only groups would recall more information than subjects provided with only a map outline. If cross-representational access is a salient aspect of conjoint retention, then both groups should be able to retrieve the same types of map and text information from memory. Moreover, because of the economical representation of imagens, or pictoral stimuli (Paivio, 1986), the icons-only group should outperform the labels-only group in retrieving information from the map and from the text.

In addition, we were interested in examining a student's belief about response accuracy. Confidence in responding has been studied in relation to a student's performance on verbal-propositional material. The literature in this domain reveals conflicting findings. Kulhavy and Stock (1989) proposed a model of feedback processing that postulates response confidence as a stable variable in memory that moderates learning a particular response. However, the results of subsequent studies (e.g., Stock, Kulhavy, Pridemore, & Krug, 1992; Webb, Stock, & McCarthy, in press) suggest that response confidence is a product of the metacognitive processes of initially learning a response, but that the measure of response confidence is not permanently stored in memory.

Because conjoint retention paradigms appear to produce higher recall of information (indicating presumably more information available and accessible in memory), we predicted that the confidence with which correct features are remembered would be higher when students have a map with both icons and labels to help them retrieve them from the story. Furthermore, we expected students provided with the icons-only map to recall information from the narrative with greater confidence than those students given the labels-only map. This prediction follows from the assumption of an economical representation of information in spatial memory. The information accessible to working memory should be greater than that from verbal memory. In addition, we believed that response confidence would dissipate over time because of its transitory nature in working memory. Thus we predicted that there would be a significant decrease in degree of confidence from the immediate test to the delayed test (6 weeks later) for memory of features and nonfeatures.

In the present study, we addressed the relative effectiveness of the various retrieval cues, the durability of these retrieval cues over time, and the degree of confidence in responding that the various retrieval cues give students. We tested students for their ability to recall features and nonfeatures, confidence for recalling those items correctly, and accuracy in placing map features in their proper locations on an outline of the map.

Method Design and Subjects

The base design crossed four levels of map cues with two levels of test-item types and nested trials within each between-subjects cell, Thus, the resulting design was a 4 x 2 x 2 (Map Cue x Item Type x Test Occasion) factorial with repeated measures on the item type and test occasion variables. The four levels of the Map Cue factor were (a) boundary only, (b) boundary and iconic features, (c) boundary and verbal labels, and (d) original map. Test item type consisted of feature-related and non-feature-related information in an auded prose narrative. Subjects were tested for their recall and reproduction of the map immediately after hearing the narration (immediate test) and at 6 weeks (delayed test).

Ninety-six fifth-grade students from four sections of science and social studies classes participated in the present study. These students came from an upper middle class elementary school in the southwest United States. Students were randomly assigned to classes initially and subsequently to one of the four map cue conditions.

Materials

We used a 1,054-word prose passage describing a fictitious island and its inhabitants (The Island of Ako and Its People) as the experimental text. The passage consisted of 16 paragraphs of approximately 66 words per paragraph. These paragraphs had been previously normed for readability using fifth-grade students (see Abel & Kulhavy, 1986). The subjects in the norming sample were found to be familiar with all the text vocabulary except those words invented for places, plants, and animals on the island. From this passage, 16 nouns were chosen from each of the 16 paragraphs as map features. The following are excerpts from the narrative:

Most of the food on Ako comes from fishing and farming. Men work in the fields outside the village growing sweet potatoes, beans, and rice. The main food is taken from these vegetables and the Snake River. Seafood is caught by throwing brightly colored nets--different colors attract different kinds of sea creatures.

The women make cloth for clothes by weaving banana leaves together. Brightly colored sea horses, collected from the sea, are used to decorate the cloth when it is made. The patterns on the material are abstract designs created by the women.

In this particular example, fields, village, and Snake River are feature items found on the map. Banana leaves and sea horses are nonfeature items not shown on the map. Features and nonfeatures were included in the text twice. The text was printed, doublespaced on 8.5 x 1 l-in. white paper and stapled into booklets. Mimetic icons depicting the features were used on the stimulus maps. On an initial study map depicting the island, features were identified with both verbal labels and mimetic icons. Figure I shows the study map as it was viewed during the learning phase of the experiment.

Four types of stimulus maps were used to cue recall: (a) the original study map as shown in Figure 1 (complete map with icons and labels), (b) an identical map with labels only, (c) an identical map with icons only, and (d) an identical map that only had the island boundary. The maps were presented on 8.5 x 11-in. white paper and organized spatially with consideration for direction and location of each item. Sixteen feature-related and 16 non-feature-related test items were constructed to test content that could be answered only by the information available in the passage. Test items were one-word completion sentences that required subjects to recall the features and nonfeatures. For the excerpts of text given above, sample test items included the following:
The men harvest food from the (fields) and the sea, and the women cook it for their families. (Feature item)
Things that the natives wear are constructed from (banana leaves) . (Nonfeature item)

***DIAGRAM: FIGURE 1.* The original study map used during the learning phase and for the Map Cue 1 retrieval condition.**

Test items were printed on separate sheets of 8.5 x 5.5-in. white paper and stapled into booklets with a front sheet of instructions. The order of items was separately randomized for each subject on each test occasion.

Procedure

The subjects participated in their normal classrooms, with 25 to 30 present in each of four sessions. After the students were seated, they were told that they were to study a map of an island, hear a story about life on that island, and then take a test on both the story and the map. After answering any procedural questions, the experimenter distributed copies of the study map and gave students 2 min in which to study it. Following this, the experimenter recited each map label and had the students place a check mark next to each feature on the map as it was recited. A tape recording of the related narrative was then presented at a speed of about 100 words per minute. The narrative, which was recorded by a female, was played twice with a 30-s interval between presentations. The students were allowed to look at the study map as they listened to the narrative.

After the second presentation of the narrative, the experimenter collected the maps. Students were then trained to use an instrument to rate their confidence concerning the responses they made to the test items. This instrument, locally developed and normed, uses a 5-point, Likert-type scale that allows students to indicate how certain they are that their responses are correct (1 = not certain: 3 = somewhat certain; 5 = absolutely certain; Points 2 and 4 are not labeled). The scale was designed to standardize the definition and use of points on the scale. The experimenter read the directions, explained each point on the scale, and had all students complete a practice exercise using the scale.

A prerandomized group of envelopes, each containing one of the four types of between-subjects stimulus maps and the feature/non-feature-related test, were distributed. There were about equal numbers of subjects in each between-subjects group present at each testing session. The subjects were told that they would be taking a test concerning the story that they would hear and that the map in the envelope would help them on the test. They were also told that the map they received might be different from the one they initially studied, but that the questions they answered were based on the type of map they received. The subjects opened their envelopes and began the test. There was no time limit for completion of the test. When the subjects finished, they raised their hand, and the experimenter instructed them to put the map and test in their envelope and place the envelope under their desk.

Next, the experimenter gave an outline of the map on an 8.5 x 11-in. sheet of white paper to students when they completed the test. Subjects were asked to reconstruct the original map as best they could using what features and names (icons and labels) they could remember. There was no time limit for this task. When the students finished this task, they placed their reconstructed map in their envelope.

Finally, the experimenter distributed an 8.5 x 11-in. white sheet of paper listing the map features. Students were asked to rate their confidence for each feature that they remembered and for the location on the map that they indicated for each feature. This sheet was then put in the envelope, and all envelopes were collected. The entire experimental procedure took about 40 to 45 min. Six weeks later, both the test containing the 32 feature and nonfeature items and the map reconstruction tasks were repeated. Because of unavoidable time constraints, response confidence was not solicited at 6 weeks on the map reconstruction task.

Results

Twenty-three protocols had to be eliminated from the data base because of student errors. Thus, 73 participants constituted the data sample for which the analyses were performed. Sample sizes for each between-subjects map condition were 19, 17, 16, and 21 for the original map (icons and labels), icons-only map, labels-only map, and a map with only the island boundary (no labels or icons), respectively. For all analyses, the rejection level was set at an alpha < .05 level of statistical significance. Preplanned comparisons were evaluated at an alpha = .01 level. Each student received 1 point for each correct response on the recall test, for each feature recalled on the map reconstruction tasks, and for each feature placed in its proper location on the map reconstruction tasks. Confidence scores for responding on the immediate and delayed tests and confidence scores on the immediate reconstruction task ranged from I (low confidence) to 5 (high confidence). Average confidence was calculated for each subject.

Correct Recall of Features and Nonfeatures

Table I contains means and standard deviations for the proportions of correct responses made for features and nonfeatures in the text. A 4 x 2 x 2 (Map Cue x Item Type x Test Occasion) unweighted means analysis of variance (ANOVA) for recall of text material revealed statistically significant main effects for map cue, $F(3,68) = 6,63$, $MS_e = 0.25$; item type, $F(1,68) = 494.69$, $MS_e = 0.23$; and test occasion, $F(1,68) = 605.45$, $MS_e = 0.14$. Significant interactions included Map Cue x Item Type, $F(3,68) = 3.35$, $MS_e = 0.23$; Map Cue x Test Occasion, $F(3,68) = 3.45$, $MS_e = 0.14$; Item Type x Test Occasion, $F(1,68) = 42.93$, $MS_e = 0.12$; and Map Cue x Item Type x Test Occasion, $F(3,68) = 3.17$, $MS_e = 0.12$.

TABLE 1: ***Means and Standard Deviations for Proportions of Feature and Nonfeature Items Recalled From the Narrative on the Immediate and Delayed Tests***

Legend for Chart:

A - Map cue
B - Immediate, M
C - Immediate, SD
D - Delayed, M
E - Delayed, SD

A	B	C	D	E
	Features			
Icons & labels	.77	.42	.76	.49
Icons only	.40	.43	.35	.48
Labels only	.31	.47	.33	.49
Map outline (no icons or labels)	.14	.49	.09	.46
	Non features			
Icons & labels	.68	.46	.61	.35
Icons only	.38	.47	.30	.29
Labels only	.35	.48	.29	.29
Map outline (no icons or labels)	.09	.46	.11	.31

We performed single degree-of-freedom contrasts to compare the four map cue conditions to determine which map(s) was(were) more effective in activating memory for features and nonfeatures. The original study map (with icons and labels) was superior to the other map types in cuing recall of both features and nonfeatures, F(1,68) = 11.39. Students who viewed the map with labels only outperformed those who viewed only the map border for features and nonfeatures, F(I, 68) = 5.57. The students appeared to recall more correct features than non-features when they viewed either the original study map or the icons-only map, F(1,68) = 6.18. The subjects recalled more features than nonfeatures correctly on the immediate test when icons only or both icons and labels were presented as memory cues, F(1,68) = 7.18.

Response Confidence for Features and Nonfeatures

Mean confidence for feature and nonfeature responses was examined by a 4 x 2 x 2 (Map Cue x Item Type x Test Occasion) unweighted means ANOVA. Statistically significant main effects were found for map cue, F(3,67) = 9.24, MS_e = 3.48; item type, F(1,67) = 404.96, MS_e = 1.96; and test occasion, F(1,67) = 884.62, MS_e = 1.57. Significant interactions materialized for Map Cue X Item Type, F(3,67) = 7.28, MS_e = 1.96; Map Cue x Test Occasion, F(3,67) = 3.45, MS_e = 1.57; and Item Type x Test Occasion, F(1,67) = 47.99, MS_e = 1.36. Mean confidence ratings for features and nonfeatures are shown in Table 2. Students were more confident of their answers on the immediate test than on the delayed test and for feature items than for nonfeature items. Orthogonal contrasts indicated that students who viewed the original study map as a retrieval cue were more confident of their responses for both features and nonfeatures than were students in the three other groups, F(1,67) = 16.38. Further, orthogonal contrasts indicated that students were able to recall significantly more features than nonfeatures when given the original map or the icons-only map than when given the labels-only map or the map outline, F(1,67) = 11.42. Students given a labels-only map were more confident of their answers on the immediate test than those given a map outline, F(1,67) = 47.99.

TABLE 2: ***Means and Standard Deviations for Response Confidence of Retrieving Feature and Nonfeature Items From the Narrative on the Immediate and Delayed Tests***

Legend for Chart:

A - Map cue
B - Immediate, M
C - Immediate, SD
D - Delayed, M
E - Delayed, SD

A	B	C	D	E
	Features			
Icons & labels	4.19	1.17	2.72	1.57
Icons only	4.14	1.23	2.62	1.49
Labels only	3.88	1.42	2.48	1.53
Map outline (no icons or labels)	3.51	1.58	2.31	1.56
	Non features			
Icons & labels	2.99	1.57	2.10	1.41
Icons only	2.73	1.49	1.92	1.27
Labels only	2.92	1.62	1.82	1.17
Map outline (no icons or labels)	2.70	1.55	1.93	1.34

Map Reconstruction

Map reconstruction for features and feature location was examined by two analyses for performance in each map cue group across test occasions. Table 3 contains the means and standard deviations for the proportions of correct recall of map features and the correct placement of those features on the map outline. A 4 x 2 (Map Cue x Test Occasion) ANOVA revealed statistically significant main effects for map type, F(3,69) = 3.47, MS_e = 0.25, and test occasion, F(1,69) = 433.50, MS_e = 0.16. The students recalled more features on the immediate map reconstruction test than on the delayed map reconstruction test. Single degree-of-freedom contrasts indicated superior recall of features for students who were given the original map and icons-only map versus the labels-only map and map outline, F(1,69) = 7.02.

TABLE 3: ***Means and Standard Deviations for Proportions of Features and Feature Locations on the Map Reconstruction Tasks***

Legend for Chart:

A - Map cue
B - Immediate, M
C - Immediate, SD
D - Delayed, M
E - Delayed, SD

A	B	C	D	E
Feature recall				
Icons & labels	.82	.38	.45	.50
Icons only	.85	.35	.49	.47
Labels only	.78	.41	.46	.50
Map outline (no icons or labels)	.76	.43	.45	.49
Feature location				
icons & labels	.84	.37	.37	.48
Icons only	.84	.36	.47	.50
Labels only	.79	.41	.38	.49
Map outline (no icons or labels)	.72	.45	.36	.48

A 4 x 2 (Map Cue x Test Occasion) ANOVA examining the accuracy of placing the map features in their proper locations revealed statistically significant main effects for map cue, F(3,69) = 8.43, MS_e = 0.25, and test occasion, F(I, 69) = 593.49, MS_e = 0.15. A significant interaction effect materialized for Map Cue x Test Occasion, F(3,69) = 3.44, MS_e = 0.15. Single degree-of-freedom contrasts indicated that students who used the original map or the icons-only map to cue recall outperformed those who used the labels-only map or the map outline, F(1,69) = 16.85. Students who had labels and icons or only icons to cue recall placed more map features in the correct locations on the map outline during the immediate map reconstruction test than did students who had only labels or the map outline to cue recall.

Finally, we analyzed the confidence with which students chose feature locations for feature placement on the immediate reconstruction task via a one-way ANOVA. There was a statistically significant difference between map cue conditions, F(3,69) = 10.21, MS_e = 1.54. Although confidence was relatively high in all conditions (overall mean confidence rating = 4.38), students who were aided in recall of the test items by the original study map or by the icons-only map were more confident of their chosen location placements of features than those who were given the labels-only map or the map outline [icon and labels = icons only (means of 4.60 and 4.50, respectively) > labels only = map outline (means of 4.21 and 4.18, respectively)].

Discussion

The results of the present investigation suggest that retention of classroom instruction is enhanced when verbal materials are augmented with related visual-spatial types of stimuli (e.g., a map). Recall of material was generally highest when both verbal labels and icons were included on a map. More map features than nonfeatures were retrieved from the narrative when students were cued with verbal labels plus icons or with icons only. However, verbal labels were enough to retrieve at least some feature and nonfeature information. The original study map (with icons plus labels) facilitated the correct recall of both features and nonfeatures from the narrative to a higher degree than did identical maps with icons only, labels only, or no icons or labels.

In addition, the labels-only map facilitated recall of correct features and nonfeatures from the text significantly more than did the map with no labels or icons. These results partially support our hypothesis that labels or icons only can access the same types of information. The fact that nonfeature text items were accurately retrieved suggests, however, that memory for items using the labels-only map may have been more a function of verbal-propositional coding than any cross-over links with the spatial code.

More features were retrieved on both the immediate and delayed tests when the original study map or the icons-only map was used to cue recall. This finding is consistent with our initial prediction that students using the icons-only map would outperform the labels-only map. It also supports previous research by Kulhavy and his associates concerning the economic representational nature of a map in working memory. The fact that the original study map and the icons-only map cued recall of a significant proportion of nonfeatures suggests that organized spatial arrays can activate incidental memory of data ancillary to a particular theme in addition to activating memory for more important, targeted material. It also suggests that pictorial stimuli in memory can be very detailed and are useful for encoding and retrieving related verbal information. This result may also be indicative of the cross-representational referents that afford access to identical and related verbal material, Future researchers might examine the amount of detail contained in a map as it is stored in memory and the extent of knowledge of a related narrative contained on the map. It would also be interesting to examine the degree to which transfer, iconic-to-verbal and verbal-to-iconic, is possible via the cross-representational access apparent in memory.

Response confidence was higher for recalling features than for recalling non-features, and it was highest on the immediate test for both features and nonfeatures when students were given the original study map or the icons-only map as a retrieval cue. These findings support our hypothesis that icons and labels together produce high levels of confidence in responding. The original study map and icons-only map presumably contain more information and, together with a related narrative, not only produce superior recall of information contained in the narrative (according to conjoint retention theory) but also appear to give students a higher sense of certainty regarding their answers when there are two codes to access feature and nonfeature information. This evidence also demonstrates the utility of second stratum cuing of semantic memory by a representation of a visual-spatial array in working memory.

Although the students were measurably confident of their answers on the immediate test, they were significantly less confident of those same responses 6 weeks later. This finding supports our prediction that confidence weakens over time and also supports the research by Stock, Webb, and their associates that suggests that subjective likelihood of responding is a transitory element in learning a response and seems to fade from the cognitive milieu after the response is made. Further research is needed to explore the possible differences inherent in knowledge estimation for visual-spatial and verbal-propositional material. The relatively high level of response confidence for those subjects who used only verbal labels to cue recall of the features in the narrative suggests that metacognitive estimates of response accuracy can be transferred from one memory code to another, presumably by the same referential connections that transfer feature information.

Results from the map reconstruction tasks add support to our predictions that labels are weaker than icons at accessing feature and related nonfeature information and that icons only and icons plus labels significantly increase retention of map features and the visual-spatial accuracy of map items. Subjects recalled more features from the text when they were cued by the original study map or the map with iconic features only. The accuracy with which subjects remembered the spatial locations of map features was also higher when the subjects were cued with icons only or icons plus labels. The confidence with which the students chose the locations on the map outline during the immediate reconstruction task (although relatively high in all conditions) was higher when they were cued by icons only or icons plus labels. Evidently, icons or icons plus related verbal labels presented in the context of a map and learned in conjunction with a related text not only are remembered well by students, but provide them with a high level of confidence in reconstructing the map for future use.

In summary, the results of this study provide general support for the retrieval assumption of the conjoint retention theory and the notion that conjoint retention is a structural encoding process whereby the features on a map direct the recall of related text information. Learning a text or narrative is more efficient when the text is used with a related spatial array, in this case a map. Recall of information contained in a narrative is more efficient when there are retrieval cues that use both iconic images and verbal labels or iconic images alone. At times, both types of representations seem to be able to access the other. However, because a map is stored as an intact perceptual-spatial unit, information on the map has an advantage in terms of ease of encoding and memorial recall. In addition, subjective confidence for the retrieved information is higher when icons and related verbal labels are used to cue recall. The economy of spatial representation seems to give the learner confidence in responding, at least initially after learning the information. This confidence in responding is apparently not processed as effectively as factual material. Finally, the accessibility of ancillary information using more central target information suggests that icons and verbal stimuli can similarly provide a very detailed representation of a story that is related to a visual representation.

In terms of instructional recommendations, our results suggest that school programs that routinely use reference maps to aid learning (e.g., geography, world history, military science) might benefit from using maps that contain well-defined, highly mimetic icons that represent important landmarks, features, or aspects discussed in a related prose passage such as a textbook or narrative. Such an instructional arrangement may have the effect not only of increasing retention of the material to be learned, but also of increasing students' confidence in their ability to learn the material. Although confidence in responding was a transient aspect of an initial testing sequence in the present study, such confidence in one's ability to recall information at the early stages in learning can provide the motivation for further time-on-task to study and learn the targeted information. Furthermore, we see no reason why such facilitation should not occur with other visual arrays such as charts or diagrams and for other school topics such as mathematics and science.

NOTES

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Correspondence concerning the study can be addressed to: James M. Webb, Educational Psychology Program, 405 White Hall, Kent State University, Kent, OH, 44242-0001.

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