behind an exhibit, and 14% were about the emotional feelings attached to seeing and using an exhibit. Stevenson concluded that most memories of the visit were descriptive and episodic in nature. Discussion with family members after the visit may aid in the retention and formation of memories.

Cota, A. & Bitgood, S. (1993). Recall of label content. *Visitor Behavior*. 8(4), 12-13.

This study compared recall of single and double paragraph passages. It was found that respondents recalled a lower proportion of information when they read long passages than they did when they read short passages.

McManus, P. (1994). Memories as Indicators of the Impact of Museum Visits. *Museum Management and Curatorship*, 12, 367-380.

McManus, in a memory study of an art museum exhibition, found that a follow-up, mail-back survey produced primarily visual and episodic memories (i.e., objects or things, events such as playing with a mask). No semantic memory (conceptual, factual) was found.

Ellis, J., Koran, J., Camp, B., & Koran, M. (1994). *Learning From Museum Exhibits: The Influence of Sequence and Perspective Taking Instructions.* Technical Report 1. Gainesville, FL: University of Florida Museum of Natural History.

This study examined the effects of sequence of viewing individual displays and perspective-taking instructions. Sequencing was controlled by giving individuals specific instructions about which order to view exhibits. Perspective-taking instructions had individuals take the role of a biologist, a geologist, or no perspective when viewing the exhibits. Both sequence of viewing and perspective-taking instructions were found to influence knowledge acquisition as measured by a multiple-test of knowledge.

The Museum Exhibit as a Visual Learning Medium

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A museum exhibit provides the opportunity for visitors to acquire vast quantities of information in various forms. Determining the form and content of the information to be assessed is an essential first step to evaluating the effectiveness of the exhibit as a learning medium. With reference to the information to be gained from a museum exhibit, two forms of learning are likely to be of greatest importance: *conceptual* and *visual.* These two forms of learning differ in the nature of the information retained in memory.

Conceptual learning is represented by the retention of factual information about both abstract ideas and concrete environmental characteristics. This form of learning from exhibits reflects the facts visitors learn about the exhibit topic or theme. The most important basis for the conceptual learning that may take place from exhibits is the accompanying narration. Therefore, conclusions from conceptual learning evaluations will depend to a large extent on the effectiveness of narrative information.

In contrast, visual learning refers to the visitor's memory of the visual features of the exhibits such as the objects within exhibits, textures, colors, various dimensions of shape and relationships among objects. Evaluations of visual learning can be useful for determining the effectiveness of various physical design characteristics of exhibits. Since museum exhibits provide the opportunity to become familiar with realistic features of exhibited artifacts, visual learning represents a potentially unique contribution to visitor learning that would otherwise be unobtainable. A series of research studies was conducted which addressed three basic questions concerning the evaluation of visual learning from exhibits.

First, was it possible to determine how well people remember specific items that they had previously seen in exhibit collections? Two different assessment procedures were compared for measuring visual learning: free recall and recognition tests. This provided the opportunity to determine their feasibility as measures of visual learning as well as their practicality for use in museum evaluation projects. The recall technique involves asking an individual to list previously observed physical stimuli within a specified domain, such as artifacts displayed in museum exhibits. The percent of correctly recalled items is interpreted as an indication of stored visual information. The recognition procedure involves presenting individuals with some stimuli that are identical to the originally seen. The subject is asked to indicate if each stimulus was present in the exhibit (s) or not. The degree to which subjects correctly identify previously observed stimuli presumably reflects the amount of visual information stored in memory.

The second question concerned the effect on visual learning of the number of items presented. If size of collections (number of items displayed) is found to influence the ability to remember the contents of exhibits, then further exploration would be warranted to determine if any optimal number of exhibited items would serve to maximize visual learning.

The third question dealt with the potential relationship of the amount of time spent viewing objects and the retention of visual information. Since viewing time (exhibit holding power) has been determined to have a positive relationship to the acquisition and retention of conceptual information about

exhibits (Screven, 1969, 1974, 1976; Shettel, et al, 1968; Shettel, 1973), it was expected that visual learning might similarly be influenced. The degree to which viewing time might affect visual learning would then be considered as an important focus for future exhibit evaluation research.

These three questions were the central focus of an initial study by Barnard, Loomis and Cross (1980). Both recall and recognition procedures were implemented in this study since little information is available in the literature concerning potential differences arising from these procedures as measures of visual learning in environmental settings. The study was conducted with 58 college students who were taken to a local historical museum and asked to observe several preselected exhibits followed by both recall and recognition testing. Half of the subjects viewed collections which cumulatively contained over 700 objects. The other subjects observed only half as many exhibits. A self-timing technique was also used in which each student was provided with a stopwatch and recorded the amount of time spent observing each collection. Results indicated, as predicted, that both recall and recognition performances were significantly lower for the group viewing the larger number of exhibits. Further, correlations of free recall scores with viewing time, though moderate, were consistently positive while viewing time did not correlate significantly with recognition and recall testing procedures as measures of visual learning in the museum environment. The study also indicated that these measures were reasonably sensitive to variables of importance to museum exhibit learning.

Two additional experiments were carried out by the present authors in which visual learning of museum stimuli was explored further. Both studies were conducted under laboratory conditions with a video tape reproduction of the museum visit. This video simulation procedure allowed the investigators to more accurately control the amount of time spent looking at the exhibits.

The first of these additional studies investigated the relationship between viewing time and later recognition of the exhibit contents more thoroughly. One hundred and twenty three college students participated in this study. Half of these subjects viewed 26 separate exhibits containing over 350 separate collection items while the other half were provided with 13 exhibits and a total of over 140 separate items. Exposure times were either doubled or identical to the average viewing times reported in the first study. Recognition test results replicated the finding of the previous study: significantly higher recognition rates were associated with the group viewing *fewer* exhibits[1]. Recognition scores also were higher when exposure times to the exhibits were twice those reported in the previous study. Thus, viewing time as well as the number of items viewed were both shown to be important factors in recognition. This study also demonstrated that video simulation provides a viable and valid means of investigating specific effects of exhibit design and visitor variables on visual learning.

The remaining study addressed three questions concerning the role of labels in visual learning of museum exhibit stimuli (Barnard, 1981). The first question concerned the effects of *auditory* labels on the learning and retention of the exhibit stimuli. The second question focused on the quantity and content of the labeling information provided. If retention of visual information is facilitated by auditory labeling, then larger amounts of labeling information would be expected to further enhance visual retention. Museums often provide labels which identify objects by name, period (date) and/or brief explanations of the use or importance of the objects. These three categories of label content were systematically varied in this study to determine their relative effects on the retention of the exhibit contents. Finally, since the labeling information was presented auditorily and the objects were presented visually, subjects could be provided with either auditory information only (labels), visual information only (pictures) or both auditory and visual information contiguously. Since the auditory labels and visual content of the exhibits were received through separate sensory modalities, the auditory labels may serve as additional memory cues for the visual recognition. To examine this possibility, subjects were tested with or without the auditory labels present when the recognition test was used to assess visual learning. Systematic manipulation of the above labeling conditions during initial viewing and recognition testing was accomplished by means of a video taped reproduction of 26 exhibits (193 total collection items) from a local historical museum and accompanying sound track to provide the auditory labels.

Three hundred and forty undergraduate students from Colorado State University served as subjects in this experiment. The effects of the label conditions were assessed in terms of both recognition and recall testing procedures. Recognition testing procedure was used with 257 individuals (64 males and 193 females). Recall testing was used with the remaining 83 (21 males and 62 females). Subjects were randomly distributed into 4 groups who viewed the exhibits while receiving varying auditory labeling information about each object displayed and three additional groups who received only the auditory labeling information. The labels provided to the different groups were: no label, name of each object only, name and date (period) for each object, and name, date and a short description of each object. Auditory-label-only groups were included to determine whether subjects were merely learning the labels or if the labels were contributing to retention of the visual content of the exhibits.

Participants in the recognition portion of the experiment were further divided among three testing procedures: recognition of the auditory labels alone, recognition of objects presented visually, and recognition of visually presented objects with auditory labels. Overall, these experimental manipulations yielded a total of 21 separate groups of recognition subjects and 7 recall groups. Results indicated that the effect of labels on visual learning, when assessed with the recognition procedure, was dependent upon *both* label con-

tent and the nature of the recognition test. Compared to the situation where subjects observed the exhibits with no labels and were tested with unlabeled pictures of the objects, recognition rates were significantly higher when exhibit objects had been labeled auditorily with a name only and tested with labeled pictures[2]. No other labeling conditions in this experiment resulted in significantly greater memory for exhibit contents than the purely visual presentation and test condition. Among the experimental conditions where exhibit contents were labeled and tested with labeled objects, the name only label condition produced significantly higher recognition performance than the more extensive label conditions. This suggests that added information on labels resulted in inferior visual learning to the briefer name label condition.

The recall procedure proved to be an inferior approach to the measurement of visual learning of large numbers of exhibit stimuli. The recall process was extremely exhaustive and highly susceptible to differences in motivation. There was large variability in recall scores among respondents in all conditions of the experiment, too much to adequately detect any influence of the labels. Recall would not be a suggested procedure to assess visual learning of large numbers of exhibited objects.

In general, these results indicated that visual learning of exhibited contents can be enhanced by providing a brief (name only) auditory label for each object and that this facilitative effect depends on the use of a recognition test that is also auditorily labeled.

Conclusions

The first two experiments provide clear evidence that visual learning of exhibit contents, as measured by both recall and recognition testing, *declines* as the number of items viewed *increases*. This finding suggests the importance of determining how many items should be included in exhibits and how extensive a single museum visit (number of separate exhibits) should be to maximize the ability of visitors to remember what they observed. These first two studies also indicate that longer viewing time improves the amount of visual learning that takes place. As was demonstrated by the results of the second experiment, providing for longer viewing time produced increased memory for exhibit contents. These results suggest that procedures which increase the amount of time that visitors spend observing all the exhibits are likely to increase visual learning. However, as Melton (1935) has cautioned, increasing the holding power of one exhibit may result in reduced holding power of surrounding exhibits. Thus, care must be taken to implement procedures that evenly distribute increased viewing time to all exhibits of interest.

The final study reported provides an important suggestion for enhancing visual learning with auditory labels. Labels that supply names of objects may help when the objective is to improve the viewer's later memory of the exhibit contents. However, as indicated in this study, if care is not taken to provide labels which are succinct and relevant to the exhibit contents, memory for the desired visual information might actually be impeded. Following a simple principle of brevity might help. The more concisely a label can be constructed, while covering the necessary information, the more effectively it will function as a retrieval cue for information presented in the exhibit. The results of this study also suggest that providing information via multiple modalities (e.g.,. visual and auditory), is superior to either visual alone or auditory alone.

The emphasis on visual learning of objects observed in museums is a natural outgrowth of early museum evaluation (see Robinson, 1928; Melton, 1935). These researchers carefully measured attention time to different objects and exhibit areas, but were careful not to assume that time spent attending to an object was synonymous with learning. They did apply common sense reasoning and concluded that visitors benefited more from those objects they looked at the most. Implied in their work was the possibility that attention time was positively related to learning or the number of objects remembered. Findings from the studies described in this paper verify that possibility and clearly suggest that, in general, attention time is positively correlated with visual memory for objects. Three implications can be extracted from this relationship between attention time and visual memory.

First, the design of exhibit installations can enhance objects and guide the visitor's eye in such a manner as to increase the likelihood of attending to specific objects. Design decisions about whether to display an object alone or in a group, in a period room or diorama versus an exhibit case, with objects of the same category or with heterogeneous items and how many artifacts to include in a given exhibit all have potential implications for what visitors will attend to and remember.

Second, interpretation and education can enhance visual memory. In fact, the purpose of labels, audio information and other sources of interpretation should be to communicate the relevancy of the object in a brief and understandable manner. These techniques can then serve as an efficient guide for the visitor's visual exploration which can in turn enrich memory by increasing the probability that a visitor will process or encode specific information about an object. For example, Patterson Williams (1982) has emphasized visual learning in her approach to museum education. Visitors need help in developing strategies for effectively observing museum objects. Learning will be enhanced because more information about objects will be encoded in memory, hopefully in a meaningful manner. Williams has been influenced by the perception psychologists Gibson and Gibson (1955) and their emphasis that objects we encounter in the world are rich in information if we attend to them in an effective manner.

Third, visual recognition memory assessment can prove a very useful way to assess museum learning. Visitors may be able to recognize objects seen in a museum for a long time

(even a lifetime) after a visit. Visual recognition memory is a very robust capacity. Furthermore, recognition of an object seen before can sometimes prompt recall of related information. It can be difficult to recall previously learned information, but when a related stimulus is presented and recognized, a series of associated memories often becomes available. Interpretive information learned in a museum setting may not be accessible by recall, but may return to mind when a person sees the interpreted object or a picture of the object again.

Each of these three implications involving visual memory deserve more research attention in order to better understand how the museum is a learning environment. That understanding, in turn, can help curators, educators and designers plan exhibits and programs that facilitate visitor learning.

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Footnotes

[1]The recognition data from this study were first transformed into d' scores according to signal detectability theory (Swets, 1964). The d'scores were then analyzed within a factorial analysis of variance design (number of exhibits x exposure time). The Newman-Keuls multiple range statistic was used for post hoc comparisons among treatment conditions. The level of significance was maintained at $p.<.05$ throughout.

[2]The recognition data from this study were first transformed into d'scores according to signal detectability theory and then analyzed within a 3 factor analysis of variance design (see Barnard, 1981 for details). The Newman-Keuls multiple range statistic was used for post hoc comparisons among treatment conditions. The level of significance was maintained at $p.<.05$ throughout.