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Age Differences in Memory for Concrete and Abstract Pictures

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There is considerable experimental literature showing that memory for complex pictures is relatively insensitive to age. Previous research has shown that young and old adults do not differ in their ability to recognize complex scenes. Other studies, however, using simple line drawings, do find age differences. This experiment investigated the possibility that the failure to find age differences with memory for complex pictures occurs because of memory support provided at encoding and retrieval by both the degree of visual detail (complex perceptual information) and the degree of propositional content (linguistic meaningfulness) that are represented in complex scenes. Pictures were shown to young and old subjects that differed in visual detail (complex vs simple) and propositional content (concrete vs abstract). The results indicated that age differences in picture memory emerge if the pictures are either deprived of visual detail or reduced in propositional content.

THE vast majority of research on adult age differences in memory has examined memory for verbal materials — stimuli that rely heavily on propositional representations. A smaller number of studies have been done with pictorial materials — stimuli that may also involve perceptual (i.e., visual-spatial) coding that is more isomorphic to the presented stimulus than is the case with verbal items.

The distinction between verbal and visual-spatial coding has been important in cognitive aging research because psychometric measures of cognitive functioning suggest that visual-spatial processing is more affected by normal aging than verbal-linguistic cognition. Larger age differences are found with performance tests, which are visual-spatial in nature, than with verbal tests (cf. Salthouse, 1982). With the Wechsler Adult Intelligence Scale, for example, performance tests with heavy visual-spatial components (Object Assembly, Picture Completion, Block Design, and Picture Arrangement) show large and reliable adult age differences, whereas little or no differences are found with the verbal tests (Vocabulary, Information, Comprehension, and Similarity).

There are problems with the psychometric data, however. First, the visual-spatial performance tests, in general, are more speeded than are the verbal tests. Given the known relationship between age and speed of performance (Salthouse, 1985), this confound prevents any clear interpretation of the age differences on the different subtests. Second, performance tests, more than the verbal tests, measure working memory (efficiency of current processing), whereas verbal tests, more than performance tests, measure products of past processing. Because older adults most likely have reduced working memory (e.g., Salthouse, Mitchell, Skovronek, & Babcock, 1989), it is difficult to untangle the type of processing from possible age differences in working memory.

Furthermore, the experimental memory research using nonverbal materials fails to support the conclusion from the psychometric literature of greater age difference on nonverbal tasks than verbal tasks. Winograd, Smith, and Simon (1982), for example, found that the advantage of pictures over words in memory tasks was the same in both young and older adults. As mentioned earlier, this effect is usually attributed to the advantage of pictures having concrete visual-spatial cues in addition to the more propositional, linguistic cues provided by words alone (Paivio & Csapo, 1973). If older adults are deficient in their use of visual-spatial cues, then Winograd et al. (1982) should have found a smaller picture-superiority effect for the old compared to young subjects. Although significant age differences occurred for both pictures and words in this study, the advantage of pictures over words was the same for both young and old age groups.

There is further evidence against the hypothesis of greater visual-spatial differences as a function of age in experiments examining age differences in memory for complex real-world scenes. Park, Puglisi, and Smith (1986) and Park, Royal, Dudley, and Morrell (1988) reported that young and old adults do not differ across a variety of experimental conditions in their recognition of meaningful complex pictures — stimuli with rich visual-spatial detail. Whereas these findings are in apparent conflict with the results of Pezdek (1987), who did report age differences with complex pictures, her study did not test recognition directly. Rather, Pezdek asked young and old subjects to indicate whether a picture had been changed at test (i.e., detail added or removed from the picture). Obviously, this requires a finer discrimination than the recognition measures. With a direct test of recognition (''yes-no'' responses), Park and her colleagues have failed repeatedly to find age differences in memory for complex pictures. In summary, although no age differences are found in complex picture memory, age differences have been reported when using different types of nonverbal materials such as pictures of faces (Smith & Winograd, 1979; Ferris, Crook, Clark, McCarthy, & Rae, 1980); simple line drawings (Winograd et al., 1982); and abstract designs (Arenberg, 1978; Harker & Riege, 1985).

One hypothesis that could account for differences in the age effects with different classes of nonverbal materials is the unique quality of both perceptual and propositional detail provided in complex scenes. The complex scenes are not only rich in visual perceptual detail, they are also rich in the propositional content provided by the linguistic interpretation of the meaningful pictures. Both the perceptual detail and the propositional content provide elaborative information relevant to the semantic interpretation of the picture. In other words, the semantic meaning of the complex scenes is provided by both visual detail (i.e., complexity) and by propositional content (i.e., concreteness). Faces and abstract drawings, on the other hand, are very difficult to encode verbally and to represent in propositional terms, and so are primarily represented as perceptual-spatial information. Simple line drawings are easily verbally coded, but unlike complex pictures, are deprived in the amount of visual detail provided. Thus, only complex concrete pictures have both rich visual-spatial and propositional information present in them.

For the present research, stimulus materials were constructed that either removed visual detail from complex scenes (complex to simple) or removed propositional content from the picture by rearranging the perceptual details into meaningless arrangements of lines, curves, and shadings (concrete to abstract). The experiment, therefore, was conducted to test the hypothesis that the failure to find age differences with complex pictures is due to the combined presence of both visual-spatial and linguistic-propositional elaboration. The complex scenes provide a rich stimulus environment with both perceptual and propositional cues supporting encoding and retrieval in older adults. Because of this support, age differences are reduced (Craik, 1988). If, on the other hand, the pictures are deprived in either visual detail or in the propositional meaningfulness of the visual detail, age differences should emerge.

METHOD

Subjects. — Twenty-four young (13 males and 11 females; mean age = 20.3) and 24 old subjects (12 males and 12 females; mean age = 68.2) participated in the experiment. The young subjects were college students participating for psychology extra credit, and the old subjects were community volunteers who were paid $5.00 for participating. All subjects were given a health questionnaire with one old subject reporting health as "fair," and all others reporting their health as good or excellent (young: 36% excellent, 64% good; old: 24% excellent, 72% good). In addition, all subjects were administered the Shipley (1967) vocabulary test with verbal scores of 87% and 93% for the young and old groups respectively.

Stimulus materials. — The to-be-remembered items were 30 pictures, half of which were complex scenes. These stimuli were used previously by Park et al. (1986). Each complex, concrete scene contained a central object that could be presented alone (simple pictures) or presented with extensive background detail (complex pictures). To construct the abstract pictures, an artist recombined the perceptual components of objects in each concrete picture into meaningless, abstract shapes. Exactly the same line and curve components in the concrete pictures, therefore, were used in recombination to form the abstract pictures. This procedure ensured that the same quantity of visual detail appeared in each concrete picture and its abstract counterpart so that the pictures differed only in terms of linguistic content. For each of the 30 complex scenes, there were a set of 4 possible pictures: (1) the complex scene itself (complex-concrete); (2) a simple picture containing only the central object of the complex scene (simple-concrete); (3) a meaningless representation of the complex scene (complex-abstract); and (4) a meaningless representation of the central object in the scene (simple-abstract). Half of the subjects saw the 30 concrete pictures, and the other half saw the matched abstract pictures. Within each group, half of the 30 pictures were simple and half complex, with the selection of simple and complex pictures counterbalanced across subjects. Examples of the four types of pictures are presented in Figure 1.

Because of possible ceiling effects caused by presenting only 30 pictures, an additional 30 concrete pictures were presented after the 30 target pictures, regardless of whether the first 30 items were concrete or abstract. These pictures were not used in the analyses of recognition performance, but only served as filler items to reduce the overall level of recognition performance. At recognition, each subject was presented with 120 pictures, with an equal number of foils matched in condition to the target pictures. There were two blocks of 60 pictures in recognition. One block contained the 30 target items and 30 matched foils. The remaining 60 were the 30 filler items and 30 foils. Half the subjects saw the 60-item target block prior to the 60-item filler block, and the other half saw the target block after the filler block. Recognition performance was only measured for the 30 target pictures (presented first in the acquisition list) and the 30 foils matched to those pictures. Preliminary analyses revealed that the order of blocking for target and filler items did not differ statistically, so the data were pooled in subsequent analyses.

Procedure. — Subjects were tested individually. They were told that they would be presented a series of pictures and that they later would be tested on their memory for the pictures. The instructions included the presentation of examples of the stimulus pictures they would see in the presentation list, concrete for the concrete picture group, and concrete and abstract for the abstract group because they saw the 30 concrete filler items in addition to the 30 target abstract items. Following the instructions, 60 pictures (a block of 30 target pictures followed by a block of 30 concrete filler pictures) were presented one at a time at a 5-sec rate by a Carousel projector. The slides were projected onto a large wall screen located in front of each subject. After the last slide was presented, the subjects performed a simple, arithmetic task for 2 min. They were told to write down the number 500, subtract 7, write down the new number, and continue to subtract by 7 until told to stop. After the two-min intervening task, subjects were instructed as to the recognition test. They were told to indicate "yes" on an answer sheet for any slide presented in the test that they saw

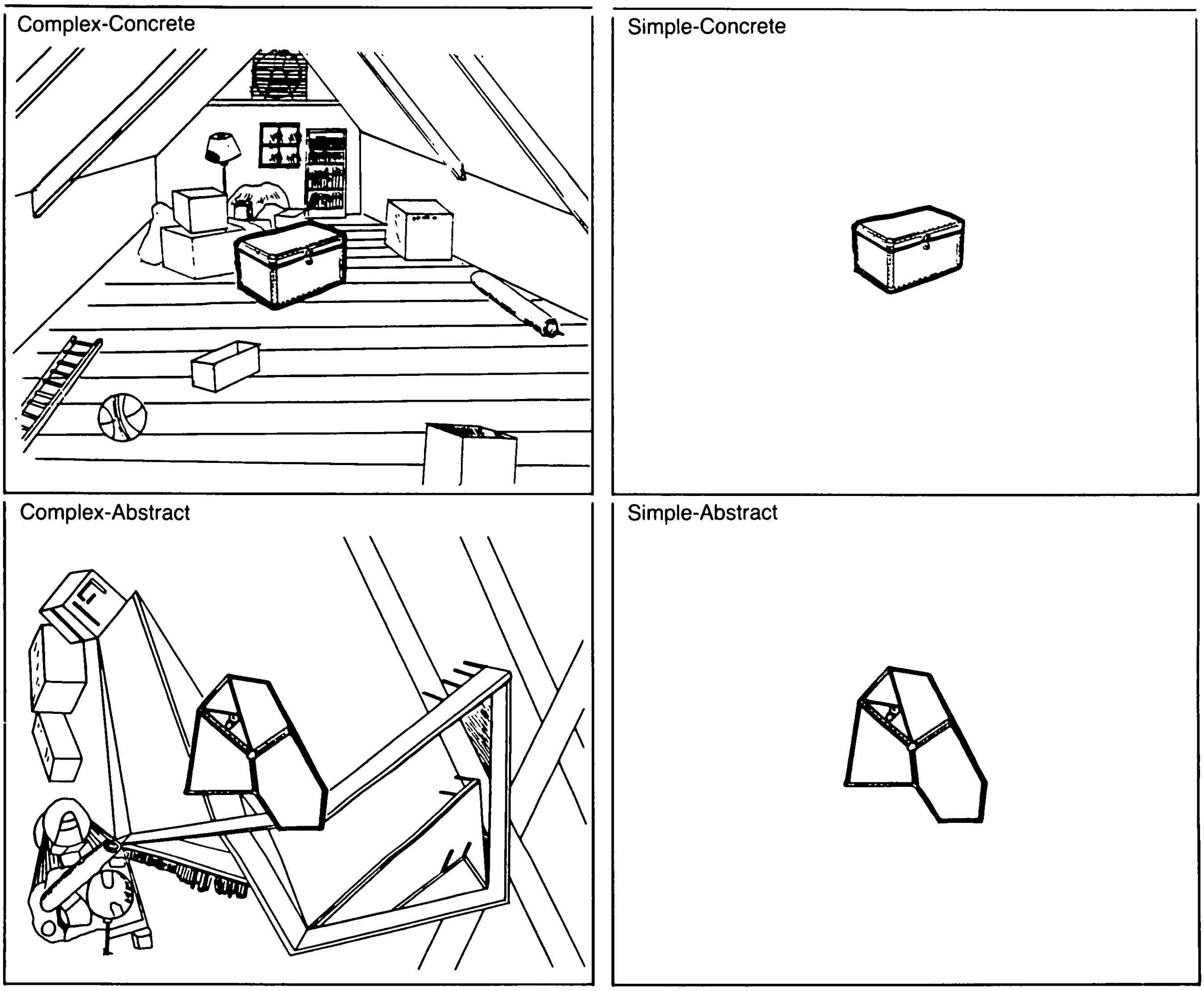

Figure 1. An example picture stimulus set showing four types of pictures: Complex-Concrete, Simple-Concrete, Complex-Abstract, and Simple-Abstract.

earlier in the presentation list, and to indicate "no" on the answer sheet if they had not seen the picture earlier. Subjects were then presented 120 pictures at an 8-sec rate, half of which were seen earlier and half of which were new.

Design. — The two between-subject variables were age (young and old) and propositional content (concrete and abstract). Complexity was manipulated within-subjects (simple and complex). Twelve subjects were run in each of the four between-subject conditions.

RESULTS

There was no effect of block order at recognition for the target information and the filler items. Furthermore, the blocking variable did not interact with any of the other variables. Because of this, the data were collapsed across block order at recognition for analysis. The mean percentage of hits and false alarms, together with d′ scores (as a correction for guessing) are presented in Table 1. Each set of measures was analyzed by analysis of variance. For the analysis of hits, only the propositional content (concreteness) variable was significant, $F(1, 44) = 5.61$, $p < .05$. Subjects made more hits with the concrete than with the abstract pictures. The only significant effect in the false-alarm analysis was for age, $F(1, 44) = 4.08$, $p < .05$, in that older subjects made more false alarms than young subjects.

In the d′ analysis, only one main effect was significant in that concrete items were recognized better than abstract items, $F(1, 44) = 14.13$, $p < .05$. The age effect, however, did approach significance, $F(1, 44) = 2.90$, $p < .10$. The interaction between age and concreteness was significant, $F(1, 44) = 4.96$, $p < .05$, and the triple interaction, between age, picture concreteness, and complexity also was significant, $F(1, 44) = 12.76$, $p < .05$.

Simple effects analyses revealed that the triple interaction was due to a significant interaction between age and complexity for the concrete pictures, but not for the abstract pictures ($p < .05$). Furthermore, age was significant for the abstract pictures, but not for the concrete pictures ($p < .05$). In other words, there were no age differences in recognition for the

Table 1. Recognition Performance as a Function of Age, Picture Complexity, and Picture Concreteness

	Hits		False Alarms		d's	
	Young	Old	Young	Old	Young	Old
Concrete						
Complex						
Mean	0.92	0.91	0.02	0.05	3.72	3.60
SD	0.07	0.07	0.05	0.09	0.49	1.08
Simple						
Mean	0.91	0.87	0.03	0.11	3.45	2.73
SD	0.06	0.10	0.05	0.07	0.77	1.00
Abstract						
Complex						
Mean	0.76	0.76	0.06	0.13	2.81	2.33
SD	0.15	0.19	0.08	0.15	1.22	1.23
Simple						
Mean	0.75	0.74	0.10	0.14	2.50	2.12
SD	0.15	0.23	0.14	0.11	1.07	1.44

complex, concrete pictures, but the age differences emerged when visual detail was removed from the pictures (complex to simple). There were also age differences when propositional content was removed (concrete to abstract), but for both the simple and complex pictures. The interaction between age and visual detail was found only with the concrete pictures. If the picture was deprived of propositional content, therefore, the complexity variable was irrelevant. When compared with complex concrete scenes, age differences were larger when either visual detail or propositional content was removed from the pictures.

Discussion

The results replicated the finding of no age differences in picture memory when the pictures are complex, real-world scenes (e.g., Park et al., 1986). There were no age differences when the pictures were both propositionally meaningful and perceptually complex. When either perceptual detail or propositional content, however, was removed from the pictures, age differences emerged. By making the concrete pictures simple (removing perceptual detail), recognition performance in the older age group declined considerably as compared to the younger age group. For the young subjects, the effect of removing perceptual detail was minimal. It should be noted that Park et al. (1986) reported no age differences for simple pictures (Experiment 2), and the current study does not replicate that finding. The finding of age differences for simple pictures, however, is consistent with many studies in the literature showing large, reliable age differences when simple line drawings are used (e.g., Park, Puglisi, & Sovacool, 1984; Puglisi & Park, 1987; Winograd et al., 1982).

Age differences also emerged when the concrete pictures were made abstract by rearranging the perceptual detail. This result replicates other studies that have used abstract designs as stimuli (Harker & Riege, 1985). Furthermore, the effect of removing perceptual detail on recognition of the abstract pictures for either age group was minimal and did not differ for the two age groups. The failure to get an interaction between age and visual detail with abstract items is similar to the finding of Salthouse (1987), who found that the effect of increasing the number of line segments in abstract drawings affected young and old subjects alike in a spatial integration task.

The effects of perceptual elaboration may be found only if the detail can support the encoding and retrieval of the picture. This is the case with a concrete picture when detail can potentially contribute to the semantic representation of the picture. With an abstract picture, however, the detail should not contribute to semantic meaning and thus provides no memory support. It appears that the degree of semantic elaboration that can provide memory support is determined by both the propositional content of the objects in the pictures and the amount of visual detail relevant to the interpretation of the picture.

The advantage, then, of concrete, complex scenes is that they provide both perceptual-spatial and propositional-symbolic elaboration to support the encoding and retrieval of older adults. While this conclusion is speculative, it does provide one explanation for the differing age effects found with different classes of nonverbal materials. Age differences are not found with complex scenes but are found when the to-be-remembered pictures are deprived in either propositional information (e.g., pictures of faces) or perceptual information (e.g., simple line drawings). It also supports the theoretical view of cognitive aging that suggests that age differences will be minimized when the cognitive task to be performed provides environmental support for the older adult (Craik, 1988). Because complex pictures are rich in both propositional content and perceptual content, such support is provided by the memory materials themselves.

Finally, there is little evidence from these data to indicate that older subjects are unable to use perceptual (visual-spatial) information, as has been implied by the psychometric literature described earlier. The psychometric data, i.e., larger age differences on performance (visual-spatial) tests than on verbal tests, may be best interpreted by other age-correlated factors. Performance tests tend to be more speeded than verbal tests, and they involve more active working memory (active information processing) than do verbal tests, which are based primarily on the products of past processing. In fact, the present study indicates that visual-spatial information can be used to support memory performance by both young and old subjects.

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