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Picture Superiority in Free Recall: The Effects of Normal Aging and Primary Degenerative Dementia[1]

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A key factor in the decline of memory with age may be a breakdown of communication in the information network involved in memory and cognitive processing. A special case of this communication is assumed to underlie the picture superiority effect in recall. From this hypothesis it follows that the picture superiority effect should lessen with age. In Experiment 1, three groups of adults (young, old normal, and old memory-impaired) were tested in free recall of pictures and word lists. As predicted, the picture superiority effect declined with age. Experiment 2 replicated these findings and showed, moreover, that the picture superiority effect can be reestablished in normal old adults by instructing them to verbalize overtly during item presentation.

Key Words: Human memory, Dual coding, Verbalization

THE picture superiority effect — the memory advantage of items presented in picture form over items presented as words — has been well established in young adults. Often this effect is explained in terms of dual-coding theory (Paivio, 1971), which states that pictures are more likely than words to activate both visual and verbal memory codes. The availability of two codes facilitates retention by providing an additional means of retrieval.

Dual-coding theory is a special case of the more general and widely accepted principle of memory function that the probability of remembering an event depends on the extent to which it is put into communication with other relevant information held in memory. That is, the more information activated by a stimulus, the greater the probability that it will be remembered because the activated information serves as multiple cues, or routes, by which the stimulus can be retrieved. This view is supported by a large number of studies showing that memory can be improved by procedures that encourage more extensive activation, such as associational and mediational techniques.

There is considerable evidence to suggest that a key factor in age-related memory decline is the reduction of this activation. Older adults use mediators in learning less frequently and less effectively than young adults (Hulicka & Grossman, 1967). There is also evidence that older adults do not process items to the same "depth" or degree of "elaboration" as young adults do (Simon, 1979).

That reduced activation is responsible, in some part, for age-related decrements in performance is further suggested by studies that demonstrate that instructions given to older adults to use mediation and elaboration can bring their performance close to that of young adults (Perlmutter, 1979; Treat & Reese, 1976).

The present investigation is based on the hypothesis that with increasing age there is a breakdown of communication in the information network involved in memory. The links in this network or the linking process become less reliable, so that given a to-be-remembered event, less information is activated. The result is that the probability of remembering is lowered.

The picture superiority effect is an example of the advantage of more extensive activation. If activation is reduced with aging, pictures should lose their memory advantage, and the picture superiority effect should be diminished in older adults. The

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following experiment was designed to investigate this possibility.

Some findings of aging effects on visual memory (Winograd & Simon, 1980) are in line with the prediction of a reduced picture superiority effect. Two studies of the picture superiority effect in recall, however, present negative (Keitz & Gounard, 1976) or conflicting findings (Winograd et al., 1982). These studies will be discussed later.

The experiments to be presented here involve the separate evaluation of three groups. They are young adults with normal memory, older adults with memory that is normal for their age, and older adults with the significant memory impairment of primary degenerative dementia. The distinction between the two older groups is an important one, and one that is not generally made. Its purpose is to enable separate evaluation of the effects of normal aging and senile dementia on memory. Some of the inconsistencies in the literature on memory in aging may be due to the varying compositions of the old groups, which, without baseline memory testing, are likely to include some memory-impaired individuals. This issue will also be addressed later.

EXPERIMENT 1

METHOD

Lists of pictures and lists of labels of those pictures were presented to young, old normal, and old memory-impaired groups. Every person recalled two lists of pictures and two lists of words. The difference between the recall scores on the picture and word lists was the measure of the picture superiority effect. After completion of the recall lists all individuals were tested on the vocabulary subtest of the Wechsler Adult Intelligence Scale (Wechsler, 1955) and the Guild Memory Test (Crook et al., 1980; Gilbert et al., 1974).

Participants. — Three groups were tested. The young group comprised 36 undergraduates, 12 men and 24 women, mean age 18.4, who were fulfilling a course requirement. The old normal group comprised primarily volunteers from local community organizations for older adults. Most of the old impaired group comprised volunteers from the local community who were participating in the Geriatric Study and Treatment Program of the Department of Psychiatry at New York University Medical Center. Five of the old impaired individuals, however, were volunteers from the local community who were classified as impaired on the basis of our testing. There were 36 in the old normal group, 10 men and 26 women, with a mean age of 72.7. There were 22 in the old impaired group, 12 men and 10 women, mean age 73.0.

The old groups were classified with respect to memory impairment on the basis of the Guild Memory Test, a set of standardized recall tests involving paragraph recall, paired associates, and design recall. Those whose performance was within normal limits for their age and vocabulary level were assigned to the old normal group. Those whose performance was more than one standard deviation below the mean on two or more of the five subtests were assigned to the old impaired group. The impaired individuals were diagnosed as having primary degenerative dementia at the Department of Psychiatry, New York University Medical Center.

Three individuals with a score of zero on two or more of the subtests were excluded because severely impaired individuals cannot perform the type of recall tasks used in the present experiment. Individuals who had significant visual or auditory impairment or who were on chronic psychotropic medication were also excluded.

Vocabulary level was slightly lower for the old impaired group than the old normal group. The mean scores were 65.6 and 70.6, respectively. The mean score for the young normal group was 59.9. (This low score was not a problem in this study because the young showed the usual memory advantage and the usual pictorial superiority effect. If it had any effect it would have worked against establishing the pattern of results we predicted.)

Materials. — Four 15-item picture sets were constructed from a standardized set of 260 pictures (Snodgrass & Vanderwart, 1980). Four matched lists of their verbal labels were also constructed. Items included in the lists met the following criteria. The pictures were those for which participants showed a high degree of agreement in their labels according to the Snodgrass-Vanderwart norms. The labels were three to seven letters in length and were of high normative frequency (A and AA words from Thorndike & Lorge, 1944).

The four pairs of lists were matched for word length, word frequency, and naming agreement. A set of practice lists was also constructed; it consisted of a 3-picture and a 15-picture list and a 3-word and a 15-word list. Each picture and word was on a separate card.

The lists were presented in a counterbalanced arrangement so that half the individuals in each group had half the items in pictorial form and the

other half in verbal form. The remaining people in each group had the form of those items reversed.

Procedure. — Participants were tested individually. They viewed each successive list silently as it was shown by the experimenter at a rate of 3 s per item. The fact that the viewing was silent should be emphasized. This aspect of the procedure turned out to be important. There was immediate oral free recall of each list. Presentation was in blocks, with half the participants in each group receiving two picture lists first and the other half two word lists first. A 3-item practice list and a 15-item practice list of the appropriate form were presented before each block. Both the order of presentation of the lists within a block and the order of items within the lists were randomized independently for each person.

After the recall lists were completed, the participants were again shown the pictures they had seen in their picture lists and asked to name each one. All participants could name every picture shown them. In five cases they used a name that differed from the one given as most frequent in the norms. In those five cases, the scoring of recall was based on the names given by the person.

RESULTS

The results are displayed in Table 1. The overall recall performance (for pictures and words combined) showed the expected pattern: The scores of the young normal adults were higher than those of the old normal adults who in turn had higher scores than the old impaired adults. The overall effect for group was significant $F\ (2,\ 91) = 63.93$, $p < .0005$, $\omega^2 = .57$. The other main effect was pictures versus words, $F\ (1, 91) = 25.78$, $p < .0005$, $\omega^2 = .18$.

Of specific interest here, however, was the interaction of pictures versus words with each group, $F\ (2, 91) = 8.18$, $p < .001$, $\omega^2 = .11$. (The ω^2s here and subsequently were based on the appropriate between- and within-subjects error terms; see Keppel, 1973.)

The picture superiority effect was greatest in the young adults. It was much smaller for the old normal adults and minimal for the old impaired group. Orthogonal comparisons of picture versus word recall for each of the three experimental groups gave the following: for the young normal, $t(91) = 6.29$, $p < .001$, $\omega^2 = .29$; old normal, $t(91) = 1.50$, $.10 < p < .20$, $\omega^2 = .01$; old impaired, $t(91) = 0.53$, $p > .40$. Thus, the picture superiority effect was significant in the young normal group and nonsignificant in the two older groups.

Table 1. Mean Proportion of Pictures and Words Recalled by Each Group in Experiments 1 and 2

Stimuli	Young	Old normal	Old impaired
	Experiment 1 (no naming)		
Pictures	.66 (.13)	.45 (.08)	.29 (.12)
Words	.54 (.13)	.43 (.12)	.28 (.11)
	Experiment 2 (no naming)		
Pictures	.67 (.12)	.46 (.08)	.25 (.10)
Words	.54 (.11)	.44 (.11)	.24 (.10)
	Experiment 2 (naming)		
Pictures	.68 (.08)	.56 (.10)	.23 (.11)
Words	.55 (.11)	.46 (.10)	.21 (.08)

Note. Standard deviations appear in parentheses.

A question might be raised, however, about the drop in the picture superiority effect in the older groups. The drop may have resulted from the overall lower performance of the older groups. For example, suppose the performance of the young group was 10 items on the picture list and 7 on the word list, giving a picture superiority effect of 3. Suppose further that the older adults had basically the same pattern but functioned at only 75% of the efficiency of the young adults on any list. Their scores then would be 7.5 and 5.25 items on the two types of lists, giving a picture superiority effect of 2.25. In other words, the absolute superiority effect may have been a simple result of a proportional lowering of performance.

To check this, each individual's score was converted to eliminate the overall level of performance. We took the number of picture items recalled and divided by the total number of items recalled. For example, a person who recalled 10 picture items and 7 word items received a score of $10/(10 + 7) = .588$. The person who recalled 7.5 picture items and 5.25 word items received a score of $7.5/(7.5 + 5.25)$ also equal to .588. This scoring made the proportion of pictures recalled conditional on the overall proportion recalled. The picture superiority effect was indicated by values above .5.

The three groups had the following mean conditional proportions of picture items recalled: young adults, .549; old normal adults, .521; and old impaired adults, .505. Analysis of variance of these proportions revealed a significant effect of group, $F\ (2, 91) = 3.75$, $p < .05$, $\omega^2 = .05$. The proportions also were converted by the arcsine transformation and analyzed. The same results were ob-

tained. Thus, the reduced picture superiority effect in the older groups was not due to their overall lower performance.

DISCUSSION

The results clearly show both the overall decline in memory with age and the reduction of the picture superiority effect with age. Both effects were predicted on the basis of the communication-aging hypothesis. The overall decline has been well established. The drop in the picture superiority effect is the prediction and finding of interest. The prediction arises from the interpretation of the effect as due to the more extensive activation normally occurring with picture stimuli in young adults and the reduction in such activation with aging.

This finding, however, is not supported in two preceding studies of recall. Winograd et al. (1982) carried out three experiments using single trial free recall of picture lists and word lists. The results were mixed. In their first experiment the interaction of age and picture superiority effect predicted here was found. Young adults showed the picture superiority effect; old adults did not. In a second experiment the interaction was not replicated. The interpretation of that experiment is unclear, however, in that the young adults also did not show much of a picture superiority effect. A third experiment was conducted to reconcile the findings of the first two. No interaction was found. In another study, Keitz and Gounard (1976) used a repeated free recall procedure. They presented 20 pictures or their labels to groups of 10 young and 10 old adults each. They did not find an interaction of stimulus type with age.

The differences in the findings between the present and the preceding studies may be due to a difference in procedure, namely, in the control of the participants' overt verbalization. In Experiment 1, reported here, the participants viewed both words and pictures silently by instruction and the silence was strictly enforced. This was done to make sure that the participants' initial processing of the stimuli was the same and that overt verbalization was not playing a major role in the performance. By contrast, Winograd et al. (1982) required the participants in their Experiments 1 and 2 to name the pictures and read the words aloud. In their Experiment 3, participants were instructed to view the stimuli silently. This experiment was conducted in groups, however, and it is possible that the participants were naming the items quietly. Testing participants individually, we found that some required repeated reminders during the practice lists before they stopped all overt verbalization. In the Keitz and Gounard (1976) study, overt verbalization did occur, because repeated free recall was used, and each trial involved naming of the list items.

There is, moreover, other evidence that the age difference in the recall of pictorial stimuli is reduced when relevant phonemic information is made directly available. Arenberg (1977) found that providing auditory descriptions of geometric figures during presentation improved the recall performance of old adults more than young adults, when compared with silent, visual presentation. Older adults seem to be less likely than young adults to use related verbal information when processing pictorial material. To determine whether overt verbalization could be the factor involved in the difference in findings and to explore aging and the picture superiority effect further, Experiment 2 was carried out.

EXPERIMENT 2

There were two main purposes of this study. One was to replicate the findings of Experiment 1. The other was to investigate a possible reason for the difference in results between that study and preceding studies. To accomplish the second purpose we examined the role of overt verbalization of stimuli in the picture superiority effect. Half the individuals in this experiment were assigned to a silent viewing condition, and the other half to an overt verbalization condition. The first condition was the same as in Experiment 1. Participants viewed the stimuli, either words or pictures, silently. In the other condition, participants named (or read) each stimulus aloud as it was presented. The expectations were as follows:

1. In the silent viewing condition the same pattern of results as in Experiment 1 would be observed.
2. In the overt verbalization condition the instructions might force the participants to do more extensive coding of the pictures (the activation of phonemic information) if they do not do so on their own. Therefore, under this procedure the picture superiority effect should reappear to some extent in the old adults.

METHOD

Materials. — The method and materials were the same as in Experiment 1. Participants were each shown two lists of pictures and two lists of words

and gave immediate free verbal recall. The only difference was the addition of a second condition, in which participants were instructed to name or read the stimuli aloud.

Participants. — The same criteria were used in selecting participants as in Experiment 1. The older adults were again divided into two groups, old normal and old impaired, based on their performance on the Guild Memory Test. The impaired older adults were all diagnosed as having primary degenerative dementia. There were 36 people in the young normal group, 36 in the old normal group, and 20 in the old impaired group. Half of those in each group were assigned to the no-naming (silent) condition and half to the naming (overt verbalization) condition.

In the young normal group, the no-naming conditioned contained 7 men and 11 women, mean age 20.4 years and mean vocabulary score 60.3. In the naming condition there were 9 men and 9 women, mean age 19.2 years and mean vocabulary score 59.1. For the old normal group, the no-naming condition contained 6 men and 12 women, mean age 71.6 and mean vocabulary score 72.1; the naming condition had 5 men and 13 women, mean age 73.1 and mean vocabulary score 71.6. The old impaired group had, in the no-naming condition, 4 men and 6 women, mean age 70.7 and mean vocabulary score 62.1 and, in the naming condition, 5 men and 5 women, mean age 72.2 and mean vocabulary score 60.8.

Procedure. — The procedure in the no-naming condition was the same as that in Experiment 1. The procedure in the naming condition differed only in that the participants were instructed to name each picture, using one word, or read each word, aloud. All participants successfully named or read all the stimuli within the 3-s presentation interval. In six instances, participants gave atypical names to pictures. Those names were used in scoring the recall of those individuals. In the no-naming condition, as in Experiment 1, participants were asked to name all the pictures after recall of all lists had been completed. All succeeded on all pictures. Recall instructions were the same for all conditions.

RESULTS

The overall results showed the decline in recall from young normal to old normal to old impaired groups, $F(2, 86) = 119.08$, $p < .001$, $\omega^2 = .72$, and the effect of pictures versus words, $F(1, 86) = 52.80$, $p < .001$, $\omega^2 = .32$. There was also an interaction of pictures versus words with groups, $F(2, 86) = 8.49$, $p < .001$, $\omega^2 = .09$. No other interactions were statistically significant. An interaction of pictures versus words by groups with naming was expected but was not found. It will be shown, however, by means of planned comparisons, that the expected pattern did hold. It is not detected by the unfocussed, higher order interaction test. In order to examine the effects relevant to the hypothesis, the results of the no-naming and naming conditions are examined separately. The same type of orthogonal comparisons carried out in Experiment 1 were carried out here.

The results of the no-naming and naming conditions are shown in Table 1. The results for the no-naming condition completely replicated those for Experiment 1. There was again the overall decline (picture and word scores combined) in performance across the three groups. Young normal adults scored higher than old normal adults, and old normal adults scored higher than old impaired adults. Again the picture superiority effect was marked in the young normal group, considerably reduced in the old normal group, and scarcely evident in the old impaired group. Orthogonal comparisons of picture versus word recall for each of the three groups gave the following: young normal, $t(86) = 5.40$, $p < .001$, $\omega^2 = .35$; old normal, $t(86) = 0.71$, $p > .40$; old impaired, $t(86) = 0.64$, $p > .40$. Picture superiority was significant only in the young normal group.

The results for the naming condition presented a different pattern, the difference restricted to the old normal group. The overall decline across the three groups still held. The total recalled by the young group was greater than that by the old normal group, which was greater than that recalled by the old impaired group. The difference between recall of pictures and words within each group revealed, however, a marked change from the no-naming condition. The young normal adults showed again a clear picture superiority effect, and again the old impaired adults showed little evidence of the effect. The old normal adults, however, showed a significant effect. Orthogonal comparisons of picture versus word recall for each of the three groups gave the following: young normal, $t(86) = 5.26$, $p < .001$, $\omega^2 = .33$; old normal, $t(86) = 4.26$, $p < .001$, $\omega^2 = .22$; old impaired, $t(86) = 0.64$, $p > .40$. Overt verbalization increased the recall of pictures only in the old normal group.

DISCUSSION

The results of Experiment 2 replicated and extended the findings of Experiment 1. The results, therefore, provide strong support for the view that picture superiority in recall reflects the more extensive activation that occurs with pictures than with words and that this activation is reduced with age.

Young adults showed a picture superiority effect under silent viewing conditions. Their performance, moreover, was not affected by the overt verbalization of stimuli. The phonemic information provided by the naming process is evidently redundant for this group. This information is activated by the pictures alone. In older adults, however, this activation was reduced. Thus, they showed little evidence of a picture superiority under silent viewing conditions. In the naming condition, however, the older adults did show a picture superiority effect. The overt naming process insures direct activation of the related phonemic information. This is consistent with the findings of Arenberg (1977) cited earlier: presenting auditory descriptions of nonverbal stimuli improves the recall performance of old adults more than young adults.

Overt verbalization, however, does not improve the recall of words for either young or old adults. Phonemic information is activated directly by verbal stimuli. Thus, under silent viewing conditions this information is available to both young and old adults. Overt verbalization of words provides no additional information to aid memory.

The old impaired group was not helped by overt verbalization, and they did not show a picture superiority effect under either silent or overt naming conditions. This may be the result of a specific deficit, known to occur in primary degenerative dementia, in the retrieval of phonemic information, as evidenced by impaired name- and word-finding ability (Reisberg et al., 1982).

The remaining discrepancy with the preceding studies relates to the finding by Winograd et al. (1982) that, with required verbalization, older adults did not show evidence of a picture superiority effect in their Experiment 1. (This finding disagrees, of course, with their Experiments 2 and 3.)

One possible reason for that finding is the composition of the old group in that experiment. Under our procedure impaired individuals were identified and their performance evaluated separately. The old impaired group did not show any effect of verbalization. Pictures and words produced the same levels of recall with or without overt verbalization. A number of such people included in the Winograd et al. (1982) Experiment 1 would give the pattern of results found there. Their procedure did not include the evaluation and classification of participants such as the one carried out in our studies.

The discussion and analyses reported here have focussed on recall. There are indications both from the work of Park et al. (1983) and our own laboratory that the reduction of the picture superiority effect with age does not hold for recognition memory. The reasons for this require further investigation.

GENERAL DISCUSSION

The results of the present investigation may be summarized as follows. The picture superiority effect in free recall is diminished in older adults when the stimuli are viewed silently. Overt verbalization of the stimuli reinstates the picture superiority effect in old normal adults but not in old memory-impaired individuals.

These results are discussed in terms of the communication breakdown hypothesis of age-related memory decline. This hypothesis is based on the generally accepted view that normal memory depends on communication among information stores. Communication results in the activation of relevant, stored information by a stimulus event. Activation occurs via links between information stores. Retrieval of an event occurs via the information that has been activated. Given that linkages are made with less than perfect reliability, increasing the number of stores activated will increase the probability that the to-be-remembered event will be retrieved. This communication principle can account for many of the well-established phenomena of normal memory function.

In aging, communication among information stores becomes less reliable. Given a stimulus event, the activation of relevant, stored information is less extensive. The result is that the probability of successful retrieval is lower. This accounts for the poorer memory performance of older adults.

There is extensive evidence for the communication principle. Techniques that function to increase the extent of activation resulting from a to-be-remembered event improve the memory performance of young adults. These include methods of organization, such as categorization and clustering, methods of mediation, such as imagery and verbal association, and semantic elaboration. All of these techniques enhance activation by facilitating the communication between the stimulus and a pool of relevant, stored information.

Furthermore, it is these processes in which older

adults are deficient. They spontaneously use organizational techniques and mediators less frequently (Denney, 1974; Hultsch, 1974; Hulícka & Grossman, 1967) and benefit more than young adults from instructions to organize stimuli (Hultsch, 1971, 1974; Smith, 1977) and use mediators (Canestrari, 1968; Hulicka & Grossman, 1967). They are also at a greater disadvantage on tasks that provide more opportunity for organization (Heron & Craik, 1964) and semantic elaboration (Eysenck, 1974).

These findings can be explained by reduced activation and a breakdown in the underlying communication process. Items are not categorized, associations are not made, and mediators are not formed by older adults because the linkages between the stimulus and related stores of information are less likely to be made. They can be made, however, which is why special instructions to do so can reduce age differences in performance. This hypothesis also explains why the age deficit is more marked on tasks in which there is opportunity for extensive activation. Young adults take advantage of the opportunity; old adults do not.

Although this type of technique is generally effective in reducing age differences, some studies have presented negative findings. These results may be due to the heterogeneity of the older adult groups. As is clear from the results of Experiment 2 of the present investigation, the recall performance of the old normal adults improves with verbalization of the stimuli, whereas that of the old impaired adults does not. Other techniques of this type also may be effective only in reducing the memory deficits of normal aging. The inclusion of memory-impaired individuals in such investigations would result in negative findings.

This emphasizes the importance of distinguishing between memory-impaired and normal older adults in research on memory in aging. The general population of older adults includes individuals with significant memory impairment, as was demonstrated in the present investigation. Participants were recruited in a fashion similar to many other studies, and some proved to be impaired. Without initial memory testing, there is no way of knowing how many of these individuals are included in any subject group. Because the effects of normal aging and primary degenerative dementia on memory are different (as was also demonstrated here), there would be no way of predicting the performance of the group as a whole, and the results will be unreliable. Initial memory evaluation is critical. Neither the effects of normal aging on memory nor those of primary degenerative dementia can be established unless they are investigated separately.

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