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# Patterns of Memory Loss in Three Elderly Samples

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Three groups of people ranging in age from 64 to 88 years performed tasks of word generation, paired-associate recall, and free and cued recall. The groups differed in socioeconomic status, verbal intelligence, and apparent levels of daily activity. A fourth group, consisting of young undergraduates, was also tested. Results showed that whereas there were age-related differences in some tests, these age differences were strongly modulated by characteristics of the participants and characteristics of the tasks. The findings are discussed in a contextualist framework.

Jenkins (1979) made the point that a full understanding of memory performance will necessarily involve consideration of acquisition variables, test variables, materials, and subjects, and further that these four major sources of variation interact vigorously with one another. Acceptance of this position entails an acknowledgment that memory is essentially a context-sensitive phenomenon. There can be no simple general laws of memory; instead, we must look for lawful patterns of interactions to provide the basic data for our theories. The notions of encoding specificity (Tulving & Thomson, 1973), repetition of operations (Kolers, 1973), and transfer-appropriate processing (Morris, Bransford, & Franks, 1977) are examples of theoretical ideas that endorse such a relativistic view of remembering.

In this article we report the performance of three groups of older adults on a selection of memory and other cognitive tasks. Previous researchers have shown that normal aging is typically associated with decrements in memory, but in line with the view of memory previously described, the decrements are much larger with some tasks and materials than with others. For example, large age differences are usually found in free recall, but these differences are reduced or eliminated in recognition (see Craik, 1977; Salthouse, 1982, for reviews). Age decrements are also found in paired-associate learning, but again the age-related drop in performance may be reduced or eliminated by giving the older person more time to retrieve (Canestrari, 1963), more effective encoding instructions (Hulicka & Grossman, 1967; Treat & Reese, 1976), or highly associated word pairs (Canestrari, 1966). Finally, recent work has shown negligible age losses in studies involving priming (Byrd, 1984; Howard McAndrews, & Lasaga, 1981; Rabinowitz, 1986) and procedural memory tasks (Moscovitch, 1982). One way of accounting for these apparently discrepant results is by the suggestion (Craik, 1983) that different tasks involve self-initiated activities in different degrees. For example, free recall has a large reconstructive component, recognition requires less reconstruction (but the subject still has to decide whether the test item had been presented in the encoding context), and priming involves virtually no self-initiated reconstructive activity because the task is often simply to identify an item or decide whether it is a word. In line with this analysis, Rabinowitz (1986) found a 33% age decrement in cued recall, an 11% decrement in recognition, and no decrement in priming—all within the same groups of subjects.

Other studies have also reported differential age-related losses depending on the task, the materials used, and the characteristics of the subjects. For example, Spilich (1983) and Dixon, Hultsch, Simon, and von Eye (1984) found that whereas subjects of low verbal ability showed age decrements in recalling both the main ideas and the details of short texts, subjects of high verbal ability showed age decrements only for peripheral detail. Similarly, Byrd (1981) found that age differences in the recall of stories depended on how the stories were presented. With intact stories, there were age differences in recall of peripheral detail but none in recall of main ideas; with scrambled stories, however, there were large age decrements in recall of main ideas. Commenting on such findings, Hultsch and Dixon (1984) concluded that age differences are attenuated when the text is well organized, when there is prior knowledge of the topic, and when the subjects are of high verbal intelligence.

The patterns of results from list-learning studies and from the more "ecologically valid" studies of memory for text can be described in exactly the same terms: In cases where appropriate mental operations are supported or induced by the tasks at encoding and at retrieval, age differences are reduced or eliminated; on the other hand, age differences are increased in cases where appropriate operations are not driven by the task or by the materials, and the subject must necessarily initiate and orga-

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nize such operations in a more consciously controlled and effortful fashion (Craik, 1983; Hasher & Zacks, 1979). High levels of memory performance are observed when subjects are knowledgeable about the material to be remembered and when the materials themselves are compatible with the way in which the knowledge is organized. If aging is associated with a decline in the processing resources required for executing mental operations (Craik & Byrd, 1982) and this reduction affects the older person's ability to spontaneously initiate appropriate mental operations (Craik, 1983), it follows that age differences should be most pronounced when little guidance is provided at encoding and retrieval, when the material is not compatible with the subjects' knowledge base of schematic organization, and when the older subjects themselves are of lower intelligence or are relatively deficient in what may speculatively be described as *processing resources, flexibility of mind,* or *mental initiative.*

The present study was conducted to explore these ideas further. Samples of elderly people were drawn from three groups that differed in socioeconomic circumstances, levels of verbal intelligence, and engagement in social programs. One group comprised highly intelligent and relatively affluent people; a second group consisted of people who were somewhat lower in verbal intelligence and were from poorer socioeconomic circumstances, but who were very active in the community; and the third group consisted of people who were again somewhat lower in verbal intelligence and were living in less affluent circumstances, but were not enrolled in a stimulating and demanding social program. Plausibly, deficits in cognitive performance might be expected to increase from the first to the third group (Arbuckle, Gold, & Andres, 1986). For the sake of comparison, a fourth group was included in the study; this group consisted of undergraduate students (aged 18–25 years) whose level of verbal intelligence was comparable to that of the first elderly group.

Three tasks were involved in the study—free recall of words from short lists, paired-associate recall, and word generation. To explore the interactive or contextualist position already described, each of these tasks was administered under two or more conditions, with some conditions offering more support than others to appropriate mental operations. The support was provided either by cues at encoding and retrieval, or by using materials that were familiar and easy to assimilate. Thus, the recall task was run under four conditions, with no cues at either encoding or retrieval, cues at retrieval only, cues at encoding only, and cues at both encoding and retrieval. The paired-associate task was presented with highly associated pairs of words or with unrelated pairs. The word generation task was also given under two conditions; in the first condition, subjects generated words beginning with a given letter, and in the second, more constrained condition, they generated examples from a given category. The general prediction in these various tasks was that performance would reflect interactions between the type of subject and task conditions, with lowest performance being found in the least able group of elderly subjects performing the unconstrained tasks (that is, free recall with no cues, paired associates with unrelated words, and generation from letter stimuli) and highest performance found in the most able elderly group performing the relatively constrained or supported tasks (word recall with cues at encoding and retrieval, paired associates with related pairs, and generation from category stimuli). More important, interactions between tasks and subjects were predicted, such that the differences between groups would be largest with the unconstrained tasks and smallest with the constrained tasks. Finally, performance levels in the elderly groups were compared with those in the group of young subjects. On the basis of previous results it was expected that age decrements would be small or nonexistent for the highly verbal elderly subjects performing the constrained tasks.

## Method

### *Participants*

Three groups of elderly volunteers and one group of undergraduate students were studied in the present experiment. All of the subjects lived at home and cared for themselves; no institutionalized people were involved in the study. There were 20 participants in each group.

The first elderly group (Old 1) was drawn from two sources. Participants were either affluent homeowners in Orange County, California, or were upper income residents of a Leisure World retirement community in Orange County. The community provides a physically and cognitively active and enriched environment. The sample of 20 participants was chosen to be equivalent to the group of undergraduates in verbal ability, as measured by the Wechsler Adult Intelligence Scale-Revised (WAIS-R; Wechsler, 1981) Vocabulary scale. The group ranged in age from 67 to 79 years ($M$ age = 73.3 years).

The second elderly group (Old 2) consisted of individuals who had volunteered to work in the Foster Grandparent Program at Fairview State Hospital, California. This program provided a physically and cognitively active environment, and resulted in strong feelings of group affiliation and involvement in the program among the participants. The members of the present sample worked with developmentally disabled clients at Fairview. Participation in the program was limited to lower income individuals; in 1983 (when the study was conducted) the upper annual income allowable for a family of two was $11,235. The foster grandparents in the Fairview program were chosen from a large pool of applicants; those selected were judged to be above average for their age group in mental and physical vigor. Participants ranged in age from 67 to 83 years ($M$ age = 73.5) and were of lower verbal ability than were members of the Old 1 group.

The third elderly group (Old 3) consisted of lower income individuals who participated in a federally funded senior citizens' program in Orange County, California. The program offered activities that are neither physically nor cognitively demanding in nature (e.g., sing-alongs, bingo), and the people in this group were judged to be less mentally and physically active than were members of the other two elderly groups. Participants in the Old 3 group ranged in age from 64 to 88 years ($M$ age = 76.2). Their WAIS-R Vocabulary scores were equivalent to those of the members of the Old 2 group.

The fourth group of participants (young) were undergraduates from the University of California, Irvine. They were all physically and mentally active people who ranged in age from 18 to 25 years ($M$ age = 19.7). They had volunteered to participate and were given course credit for their services.

Details of ages and vocabulary scores are summarized in Sample 1 of Table 1. A univariate analysis of variance (ANOVA) on the age scores of the three elderly samples revealed no significant differences among the groups, $F(2, 57) = 1.43$, $p > .05$. A similar analysis on the vocabulary scores for all four groups revealed highly reliable differences, $F(3, 76) = 55.8$, $p < .01$. Further tests showed that the planned comparisons (at $p = .05$) between young and Old 1, and between Old 2 and Old 3,

Table 1
*Characteristics of Subjects in the Four Groups*

| Characteristic | Old 3 (senior citizens' program) | Old 2 (foster grandparents) | Old 1 (retirement community) | Young (undergraduates) |
|---|---|---|---|---|
| | | Sample 1 | | |
| Age | 76.2 | 73.5 | 73.3 | 19.7 |
| Vocabulary | 31.2 | 35.0 | 52.2 | 48.1 |
| | | Sample 2 | | |
| Age | 78.3 | 75.1 | 74.1 | 20.7 |
| Vocabulary | 34.1 | 35.5 | 53.8 | 49.2 |
| Years of education | 11.4 | 11.8 | 13.1 | 12.9 |
| % activity | 39.5 | 57.4 | 59.0 | 62.3 |

*Note.* The lines link groups that did not differ statistically. Sample 1, $n = 20$; Sample 2, $n = 25$.

were nonsignificant in either case, but that the young and Old 1 groups combined scored reliably higher than did the Old 2 and Old 3 groups combined, $t(78) = 12.61, p < .01$.

## Experimental Tasks

*Word generation.* Participants were given a letter (d or w) or a category name (birds or flowers) on each trial, and were asked to generate as many words as possible beginning with the given letter, or as many examples as possible from the given category. The participants verbalized their responses, which were immediately written down by the experimenter; a 2-min time period was allowed for responding in each case. All of the participants generated words to all four stimuli; half of the participants were given the letter tasks first and half were given the category tasks first. Similarly, the order of the two letter tasks and the two category tasks was counterbalanced within each group.

*Paired-associate recall.* On each trial, the participant was presented with eight word pairs; the task was the subsequent recall of the second word in each pair, given the first word as a cue. Each person received six such lists of eight pairs. On three of the lists the word pairs were semantically related common nouns (e.g., table–plate), and on the other three the words were common nouns with no obvious relation (e.g., wallet–donkey). These two sets of lists are referred to as high associates and low associates, respectively. Half of the participants were given the high associates first, and half were given the low associates first. On each trial, the experimenter read the eight word pairs aloud at a rate of 3 s per pair. The experimenter signaled the end of each list with a gesture and immediately presented the first member of each pair as a cue for the corresponding second member. The first members were also presented orally and in a scrambled order relative to the presentation order. Participants were given up to 10 s to recall the response members in each case. Before presenting the main series of six lists, each participant received a 3-pair practice list to ensure that he or she understood the procedure.

*Free and cued recall.* On each trial, participants were given a list of 10 common one- and two-syllable nouns; then they attempted to recall all 10 words. There were four conditions, with two lists per condition. In the first condition (free–free), the words were presented alone and the participant was given no cues during his or her free recall attempt. In the remaining conditions, short descriptive phrases were provided at retrieval only (free–cued), during presentation only (cued–free), or the same phrases were given at both presentation and retrieval (cued–cued). Examples of the phrases and words are "A type of bird–LARK," "Part of a tree–TWIG," "Used in schools–BOOK." At presentation the words (or phrases and words) were read by the experimenter at a 3-s rate. In the free-recall conditions, the participant recalled orally and the responses were recorded by the experimenter; participants were given up to 1 min to recall each list. In the cued recall conditions, the experimenter read each phrase aloud and gave the participant approximately 6 s to respond with the appropriate word, which was then recorded by the experimenter. The cues were presented in a scrambled order relative to the initial input order in all cases. The two lists in each of the four conditions were presented successively, but the order of the four conditions was randomized for each participant.

In the free–free condition, participants were told that they would hear a list of common words and should try to remember them while they were being presented. They were also told that the end of the list would be signaled by a gesture, and that they should then recall orally as many words as they could, in any order. In the free–cued condition, the presentation was the same as in the free–free condition, but at the retrieval phase they were told "To help you remember the words, I will give you a clue for each word you heard; for example, what word was part of a tree?" In the cued–free condition, participants were told that they would hear 10 words and a short description of each word; it was stressed that they need not remember the descriptions but that they should listen carefully to them as the descriptions might help them to remember the words. In the cued–cued condition, participants were told to listen carefully to the phrases during presentation; the phrases were then provided again as cues during the retrieval phase.

## Procedure

The exact procedure necessarily varied somewhat from group to group, but in all cases the aim was to test each person in quiet, undisturbed surroundings and to gain his or her confidence and co-operation. Members of the Old 1 group were tested in a room provided at the Leisure World complex; Old 2 participants were tested in the memory laboratory at Fairview Hospital; Old 3 participants were tested in a room provided at one of the senior citizens' centers; and the young people were tested in a laboratory in the Department of Social Ecology at the University of California, Irvine. All of the participants were tested individually, and testing was stopped if the person showed signs of discomfort or fatigue. Every effort was made to arrange the conditions to maximize the person's performance. The elderly participants were tested in two sessions. Test order was randomized across each group; approximately half of the testing was carried out in each session. The undergraduates were given all of the tests in one session, which lasted approximately 1 hr.

Table 2
*Mean Scores on Three Experimental Tasks*

| Task and condition | Group | | | |
|---|---|---|---|---|
| | Old 3 | Old 2 | Old 1 | Young |
| Word generation | | | | |
| Letter | 8.5 | 12.1 | 20.6 | 21.0 |
| Category | 9.3 | 10.8 | 15.2 | 17.5 |
| Paired associates | | | | |
| High | 3.9 | 5.1 | 6.3 | 6.9 |
| Low | 0.5 | 2.0 | 2.4 | 3.6 |
| Word recall | | | | |
| Cued–cued | 5.5 | 7.3 | 8.1 | 7.8 |
| Cued–free | 2.2 | 5.4 | 5.8 | 5.6 |
| Free–cued | 2.2 | 4.5 | 5.3 | 5.8 |
| Free–free | 2.4 | 4.6 | 4.7 | 6.0 |

## Results

Mean scores for each of the four groups on the various tasks are shown in Table 2. In the word-generation task, performance increased monotonically from the Old 3 group to the young group for both letters (e.g., generate as many words as possible in 2 min, beginning with d) and categories (e.g., birds or flowers). The Old 3 subjects generated slightly more words to the category than to the letter stimuli; all of the other groups generated more to the letters. An ANOVA showed a highly significant effect of groups, $F(3, 76) = 33.57$, $p < .01$; significantly higher performance in response to letters than to categories, $F(1, 76) = 30.97$, $p < .01$; and a significant interaction between groups and conditions, $F(3, 76) = 10.07$, $p < .01$. In line with the argument presented earlier, the interaction between groups and conditions can be interpreted as showing that the least able group of elderly people benefited differentially from the greater support and constraints of the category condition. The pool of possible responses is clearly much greater for letter stimuli, but generation of different words beginning with a given letter arguably demands more self-initiated activity, and thus the less able groups are relatively penalized. Post hoc Scheffé tests (at $p = .05$) revealed that performance of the Old 1 group did not differ reliably from the young group for either letter or category stimuli. However, performance of Old 2 participants was reliably lower than either the Old 1 or the young group, and Old 3 participants were significantly poorer than the Old 2 group in both conditions.

Performance on the paired-associate task again increased monotonically from Old 3 to young participants, and performance was uniformly higher with the highly associated word pairs. An ANOVA on these data yielded a significant effect of groups, $F(3, 76) = 57.37$, $p < .01$, and of high versus low associates, $F(1, 76) = 611.11$, $p < .01$. The interaction between groups and conditions was not significant, $F(3, 76) = 1.60$, $p > .05$. We had predicted that the differences in performance between groups would be less with the more supportive high associates, but in fact the drop in performance between the young and Old 3 groups was almost identical for the two types of material. Conceivably, the lack of interaction reflects a floor effect in recall of low associates.

A complex but interesting pattern appears in the word recall data. Performance increases monotonically both between groups ($M = 3.1$, 5.5, 6.0, and 6.3 for Old 3, Old 2, Old 1, and young, respectively) and between conditions ($M = 4.4$, 4.5, 4.8, and 7.2 for free–free, free–cued, cued–free, and cued–cued, respectively). A 4 × 4 ANOVA yielded significant effects of groups, $F(3, 76) = 66.7$, $p < .01$, and of conditions, $F(3, 228) = 177.5$, $p < .01$, and a significant Groups × Conditions interaction, $F(9, 228) = 4.14$, $p < .01$. The reliable interaction is again in line with the main argument of the present article that the size of the memory deficit with increasing age and declining ability depends on the specific task. To contrast the extremes shown in the word recall data in Table 2: the drop in performance from the young group to the Old 3 group is substantially greater in the free–free condition (3.6 words) than in the cued–cued condition (2.3 words).

We grouped the word recall scores in Table 2 in four performance level bands, 0–3, 3–5, 5–7, and 7–10. These four groups are highlighted in Figure 1, and one can see that they form a series of "neighborhoods" running from the lowest scores in the bottom left to the highest scores in the top right of the table. Post hoc Scheffé scores ($p = .05$) revealed that with only three exceptions, scores within each neighborhood did not differ from each other statistically, but did differ reliably from all of the scores in other neighborhoods. The three exceptions are Old 1/free–cued (5.3) and young/free–free (6.0), Old 2/cued–cued (7.3) and Old 1/cued–cued (8.1), and Old 2/cued–free (5.4) and Young/free–free (6.0). Apart from these three relatively minor deviations, the scores within each neighborhood represent approximately equivalent levels of performance running from the relatively poor performance obtained by Old 3 participants in conditions free–free, free–cued, and cued–free, to the relatively good performance shown under the cued–cued condition by the Old 2, Old 1, and young groups.

The pattern exhibited by the scores in Figure 1, and supported by the significant Groups × Conditions interaction is taken here as strong confirmation of the position that memory performance is a joint function of the person's ability level and the specific task under consideration. In particular, if the task supports appropriate mental operations at both encoding and retrieval (the cued–cued condition in the present experiment), good performance holds up relatively well across the various samples; only the Old 3 group shows a marked drop. At the

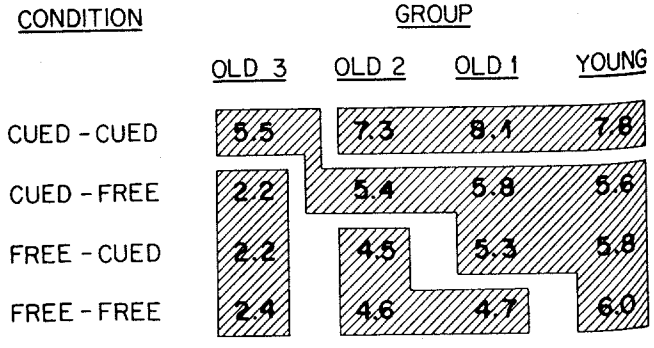


*Figure 1.* Word recall scores grouped into four levels of performance.

Table 3
*Task Intercorrelations In the Three Elderly Groups Combined*

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 1. Age | — | −.32 | −.26 | −.29 | −.21 | −.17 | −.15 | −.27 |
| 2. Vocabulary | | — | .72 | .70 | .46 | .60 | .52 | .51 |
| 3. Word generation | | | — | .67 | .54 | .58 | .58 | .63 |
| 4. Paired associates | | | | — | .75 | .77 | .71 | .71 |
| 5. Free–free | | | | | — | .76 | .67 | .65 |
| 6. Free–cued | | | | | | — | .81 | .68 |
| 7. Cued–free | | | | | | | — | .74 |
| 8. Cued–cued | | | | | | | | — |

*Note.* Correlations greater than $r = .25$ are reliable at $p < .05$. $N = 60$.

other extreme, the least able group (Old 3) does not benefit from the increasing support provided by cues until such support is given at both encoding and retrieval. A final point to note from Figure 1 is that the superior group of elderly people (Old 1) shows no reliable decrement in performance relative to the young people except under condition free–free, in which the greatest amount of self-initiated activity is required.

A further question of interest concerns the interrelations between the various measures within the total group of older people. Do the tasks tap the same cognitive abilities, and are these abilities related to age and vocabulary level from the early 60s to the mid 80s? Table 3 presents the intercorrelations among the tasks. For this purpose, the two word-generation tasks and the two paired-associate tasks were combined to form one measure in each case. Table 3 shows strong positive correlations among the verbal tasks in all cases. Also, vocabulary level is highly related to performance, and age is weakly related to task scores. However, age is also related negatively to vocabulary level, so the apparent effect of aging might be misleading for this reason. Accordingly, partial correlations were calculated between age and task variables, with vocabulary level partialed out. The resulting partial correlations were all negligible; for word generation, $r = -.05$; for paired associates, $r = -.10$; and for the four recall conditions, $r = -.07, +.02, +.02$, and $-.13$ for free–free, free–cued, cued–free, and cued–cued, respectively. It is interesting to note then that chronological age had no effect on memory performance or on word-generation ability in the elderly groups in the present study. Age was related to vocabulary level, but further analyses in each of the three samples showed that this relation varied according to the group studied. The correlation coefficients between age and vocabulary level for groups Old 1, Old 2, and Old 3 were $-.01$, $-.36$, and $-.59$, respectively. Chronological age and vocabulary level were therefore strongly related in the least able group, not at all related in the most able group, and related somewhat in the Old 2 group. The reason for this pattern is unclear; it may be a case of verbal abilities holding up to a greater extent in the initially more able group (Old 1), but equally it could reflect a greater tendency in the Old 2 and Old 3 groups for the oldest subjects to have received less adequate schooling.

## Discussion

The main point we wish to make is that cognitive performance must be viewed as a joint function of the particular tasks, participants, and materials used (Jenkins, 1979). More specifically, we argue that age deficits should not be viewed as all-or-none effects, but rather that the age differences observed will be large, small, or nonexistent depending on the tasks and materials. Further, the same patterns of differential losses appear within a large sample of elderly people, with higher performance shown by more active and highly verbal participants. Craik (1983) suggested that individual differences in memory performance are amplified as the encoding and retrieval tasks become less constraining or are afforded less environmental support; for example, differences are large in free recall and smaller in cued recall and recognition. The present tasks were chosen to vary in the degree to which they induced or supported appropriate mental operations; thus, age and sample differences were expected to be less with word generation from a category cue, with highly associated words in paired-associate recall, and with word recall when cues were provided at both encoding and retrieval. The data in Table 2 support this position in general, although the paired-associate task did not reveal the predicted interaction between groups and associative strength. The different tasks are now examined in greater detail.

### *Tasks*

The results of the word-generation task followed the predicted pattern. There is a general advantage to generating words from an initial letter, simply because there is a much larger pool of words to draw on. However, the least able group of older people (Old 3) generated more words from a given category, whereas the high vocabulary groups (Old 1 and young) generated more in the letter task. The greater constraint and guidance offered by the category stimulus is most helpful to the least able group. The present results are in line with many previous studies that have shown age losses in verbal fluency measured by the number of words produced beginning with a specified letter (see Salthouse, 1982), and with some reports showing that age losses were much smaller when participants were required to produce instances of a given category (Drachman & Leavitt, 1972; Fitzgerald, 1983; Stones, 1978). Bear in mind also that the present results, and those of previous studies, may reflect age differences that are specific to unpracticed participants. Riegel (1965) showed that age differences in word generation declined as more practice was given.

In the paired-associate task, performance increased from the

Old 3 group to the young group (Table 2) and there was a main effect of associative strength. It is surprising, however, that no interaction was found between groups and materials. In terms of *proportional* increases in performance from low to high associates, there are large differences between the groups; thus, the Old 3 group shows an eightfold increase in performance, whereas the young group less than doubled their score. This is a somewhat post hoc line of argument, however, and it may be safer to point to the undoubted floor effects for the Old 3 group on the low associates. It does seem that the present result is anomalous, inasmuch as many previous studies have shown older participants to be differentially penalized with low associates in the paired-associates task (e.g., Botwinick & Storandt, 1974; Canestrari, 1966; Kausler & Lair, 1966).

The main data of interest are the word recall results shown in Figure 1. The major point we wish to make from this table is, again, that performance reflects an interaction between the degree of support offered by the task and the ability level of the person performing the task. As the ability of participants rises from the Old 3 group to the Old 1 and young groups, participants can make progressively earlier use of the increasing constraints as the tasks shift from free–free to cued–cued. Thus, the Old 3 group performed poorly until cues were provided at both encoding and retrieval, but in this cued–cued task they performed as well as did the Old 1 and young people on free–cued and cued–free tasks. The Old 2 participants were able to improve their performance from the free–free level when cues were provided at encoding (cued–free) and to benefit further from the cued–cued condition. The Old 1 group performed reliably better on free–cued than on free–free, and the young group reached this same level of performance in the unconstrained, free–free condition. The young people are apparently able to bring reasonably effective operations to bear under free–free conditions, whereas the Old 1 participants require at least free–cued, the Old 2 participants require at least cued–free, and the Old 3 participants require cues at both input and retrieval. One surprising feature of the results is the general absence of an improvement in performance when cues are provided at retrieval (i.e., from free–free to free–cued). Two factors may account for this finding: First, under free-recall conditions, participants could choose their own output order and use their own organization of the materials, whereas with cued recall they had to respond to the cues provided by the experimenter in a new random order. Second, in order to reduce guessing, the descriptive phrases were often neither very direct nor typical descriptions (e.g., "a protector–SOLDIER"; "a covering–CURTAIN") and thus were not all that helpful unless they had also been given during the acquisition phase.

### *Groups*

The four groups studied in the present experiment varied in age, in verbal intelligence, and plausibly in levels of daily activity. Conclusions about the levels-of-activity variable must be quite tentative, however, because the lower activity levels of Old 3 participants were judged simply on the basis of informal observation. One further piece of evidence supporting the idea that Old 3 participants had lower levels of daily activity comes from an unpublished study by Byrd (1985). In this study, Byrd tested further samples of 25 people drawn from the identical populations used in the present experiment—that is, from the senior citizens' program, foster grandparent program, the Leisure World community, and University of California, Irvine, undergraduates. In Byrd's study a measure of daily activity was taken along with age, years of formal education, and WAIS-R Vocabulary scores. The measure of activity was based on Schonfield's (1973) ideas. The aim was to establish the percentage of each person's waking hours that were occupied by active, as opposed to passive, pursuits. Following Schonfield, active pursuits included domestic chores, actively preparing for visitors, visiting others, and engaging in volunteer activities and in active hobbies such as golf. Passive activities included resting, eating, reading, watching TV, and listening to the radio. The data from this second set of samples are also given in Table 1 under Sample 2. The activity measure is simply the percentage of time that the person was awake and occupied in active, as opposed to passive, pursuits.

Analyses of variance were carried out on the various measures taken on Sample 2. With respect to age, the four groups obviously showed a reliable difference, $F(3, 96) = 42.73$, $p < .01$. However, subsequent Scheffé tests ($p < .05$) showed that although the three elderly groups combined differed from the young group, the elderly groups did not differ among themselves. For vocabulary, the four groups differed reliably, $F(3, 96) = 12.12$, $p < .01$. Scheffé tests showed that the young and Old 1 groups did not differ, but were reliably higher than were the Old 2 and Old 3 groups; the latter two did not differ from each other. The same pattern held for years of formal education. There was an overall difference, $F(3, 96) = 6.97$, $p < .01$, and Scheffé tests showed that the young and Old 1 groups scored reliably higher than the Old 2 and Old 3 groups. Again, neither the first two nor the second two differed between themselves. Finally, activity scores again showed an overall difference, $F(3, 96) = 26.60$, $p < .01$. Scheffé tests showed no differences between young, Old 1, and Old 2, but did show that these three groups were superior to Old 3. On the two measures that were common to Samples 1 and 2, the samples were clearly comparable—the ages were not reliably different between the three groups of elderly participants and vocabulary scores were similar in Old 3 and Old 2, and also in Old 1 and young. Critically, Sample 2 showed that the Old 3 group had significantly lower levels of daily activity than did members of the other three groups. Although this evidence is obviously indirect, it is presented here to support the conclusion that any differences in cognitive performance between Old 3 participants and others may be associated with lower activity levels in people drawn from that source. On the basis of Sample 2 data (Table 1), it is tempting to suggest that the differences between Old 2 and Old 3 are not attributable to differences in educational level; they may be associated with differences in activity level, but any such differences may in turn depend on other factors, such as health.

Age differences in the present study depend strongly on which group of elderly people is compared with the young sample—the Old 3 group scored reliably lower on every measure, whereas the Old 1 group shows very slight differences from the young group. Clearly, the latter comparison is the more valid one be-

cause the groups are matched on verbal intelligence and (approximately, at least) on activity level. Scheffé tests on the scores of young and Old 1 groups shown in Table 2 reveal reliable differences in two cases only—paired-associates recall with low associates, and word recall under free–free conditions. In line with the present argument, these are two tasks providing little help from the materials or from external cues. Within the combined group of 60 elderly people, it is noteworthy that age did not predict cognitive ability when differences in vocabulary level were partialed out.

### *Groups × Tasks*

The major point that performance reflects interactions between particular subjects and particular tasks has been stressed already. We add to this contextualist point made by Jenkins (1979) and Dixon et al. (1984) by suggesting that age differences are greatest with tasks requiring much self-initiated mental activity, and that differences are least when the task supports or drives appropriate mental operations. The present results, and the present approach, are very much in line with the findings of Arbuckle et al. (1986), who examined memory performance in people ranging in age from 65 to 93 years. These researchers found that performance on a variety of episodic memory tasks depended strongly on social and personality factors, such as educational level, intellectual activity, and introversion.

There has been some controversy in the literature on age differences in cognition about whether old or young people can make greater use of increased meaningfulness of the materials used. Both positions are plausible; it has been argued, for example, that older people find meaningless materials (e.g., nonsense syllables) difficult and pointless, and so show a differential improvement when more "sensible" materials like stories or pictures are used. On the other hand, there is also good evidence that as meaningfulness increases, both age groups improve their performance, but that younger people can take greater advantage of the more meaningful material (see reviews by Craik, 1977, and Salthouse, 1982). The resolution suggested here is that both patterns are valid, and that whichever one is observed will depend on the interactions among tasks, materials, and subjects. Thus, as difficult materials are made slightly easier, or as the encoding task is changed to direct subjects' attention to more relevant aspects of the material, young people will typically make earlier use of the increased compatibility of the material to their knowledge structures, and so differentially improve their memory performance. However, once conditions are such that younger participants are already achieving a good encoding for the material in question, further support in terms of longer encoding times or a more useful orienting task, is likely to be of greater benefit to the older participants. An example of this pattern of results from an experiment by Treat and Reese (1976) is discussed by Craik (1983). It is not that older people fail to understand that they must carry out certain types of mental operations in order to remember well, rather it is that they are often unable to perform such operations unless the operations are supported by the materials and the task.

We make two brief points in conclusion. First, the present results underline the point that to get a full picture of cognitive changes with age, it is necessary to look at several different levels of ability; it is not sufficient to compare just one young group with one group of older people. Second, the contextualist position endorsed by the present study implies that models of human cognition that describe only intra-organismic structures and processes (e.g., the influential models of Anderson & Bower, 1973; Atkinson & Shiffrin, 1968; Broadbent, 1958; Craik & Lockhart, 1972) are inherently unsatisfactory. Theories of cognitive performance must model the interactions between mental processes and relevant aspects of the environment.

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