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EFFECT OF AGING ON IMPLICIT AND EXPLICIT MEMORY FOR NEW ASSOCIATIONS

Martial Van der Linden, Raymond Bruyer, and Bernard Dave

Université de Louvain, Neuropsychologie Cognitive
Voie du Roman Pays 20, 1348 Louvain-la-Neuve, Belgium

Abstract. *Thirty-two young and 32 elderly subjects were asked to study 24 unrelated cue-target pairs of words. Two kinds of study tasks, sentence evaluation vs sentence generation, were used in a between-subject design. In the sentence generation task, subjects were asked to generate a sentence that linked the two members of each pair. In the sentence evaluation task, subjects were shown sentences that included the target pairs and asked to assess how well these sentences related the targets to each other. This was followed by an implicit memory test (word-stem completion) and an explicit cued-recall test. In both tests, the target word was presented alone or associated with the same word or a new cue word (context) as the one used in the study stage. Firstly, in all conditions of both tests, the young subjects performed better than the elderly. Secondly, study-by-generation led to a better memory score than study-by-evaluation for the same-context condition in the implicit test, and for the young subjects in the explicit test. Thirdly, the same-context condition led to a better score than the remaining two conditions in each subgroup of the cued-recall test, and in the completion test after study-by-generation only; after study-by-evaluation, the same-context condition did not differ from the new-context condition.*

Key words: Aging, implicit memory.
Mots clés : Vieillissement, mémoire implicite.

Memory deficits resulting from normal aging are well documented (see Light, 1991). They appear mainly when memory is assessed by means of direct (or explicit) tests requiring conscious recollection (e.g., in recall and recognition tasks). However, when the subjects are tested indirectly (or implicitly), i.e., when they are not asked to recollect consciously, the age differences tend to disappear or diminish (Chiarello & Hoyer, 1988; Graf, 1990; Howard, 1988; Java & Gardiner, 1991; Light & Singh, 1987). In fact, there have been several demonstrations of (quasi-)preserved implicit memory in the elderly, for highly familiar, overlearned verbal information, i.e., well-known words (Graf, 1990; Howard, 1988). Such data are compatible with the idea that the elderly can automatically activate pre-existing representations, but cannot create new, context-specific representations that are a basis for explicit remembering (see Light, 1991). An important question concerns the existence of preserved implicit memory for contextually specific, novel verbal associations (e.g., between previously unrelated words) but at the present time, this existence still remains to be firmly established.

This form of implicit memory has generally been studied by means of the word-stem completion priming paradigm developed by Graf and Schacter (1985). Typically, subjects are shown pairs of unrelated words (e.g. "window-reason"), a target and a cue, and are required to generate a meaningful sentence including the two words. Then, they are asked to complete three-letter strings (in fact, the first three letters --or "stem"-- of the target words) by "the first word that comes to mind". The stems are paired either with the cue-word shown during the sentence construction task ("window-rea..."; same-context condition), with a different word ("ripe-rea.."; new-context condition), or are displayed alone ("rea..."; no context condition).

With this paradigm, Graf and Schacter (1985) showed that college students exhibited more completion priming in the same-context condition than in the other conditions. Schacter and Graf (1986a; Graf & Schacter, 1989) observed that students were subject to this context effect only if they were able to establish a meaningful relationship between the paired associates. However, once such a relationship has been established, the establishment of more elaborate relationships does not increase the context effects. Graf and Schacter (1985) also demonstrated that amnesic patients were affected by priming in a similar way to normals. However, Schacter and Graf (1986b) showed that such implicit memory for new associations was present only in the less impaired amnesics. In contrast, Cermak, Bleich, and Blackford (1988a) and Shimamura and Squire (1989) did not replicate the results of Graf and Schacter (1985). Indeed, they showed that amnesic performance was not affected by context. In young normal subjects, Cermak et al. also found that instructions to remember paired associates were critical for implicit contextual learning. Furthermore, they showed

that neither the amnesic nor the alcoholic control subjects showed evidence of the priming effect, even when instructions stressed the remembering of pairs. Cermak et al. concluded that the effect of implicit contextual learning may be dependent on the ability to engage in direct (intentional) learning, and that amnesic and alcoholic controls were unable to adapt their processing of the material to the recall constraints. In this respect, Mayes and Gooding (1989) noted that the degree of priming was correlated to the performance in the explicit cued recall of critical words by amnesic patients. Such findings again suggest that implicit learning for new associations may be mediated by intentional recollective processes. Along these lines, Bowers and Schacter (1990) showed that only those young people who were aware that some of the words displayed in the completion test had been presented earlier during the study phase, were subject to a context effect. This is consistent with the view that context effets simply reflect the use of explicit memory strategies. However, such a hypothesis is inconsistent with the fact that completion priming for new associations can be dissociated from explicit cued recall for new associations (which only differs from the completion test by the retrieval instructions) by different variables such as level of processing manipulations (Schacter & Graf, 1986a), proactive/retroactive interference effects (Graf & Schacter, 1987) or modality shifts (Schacter & Graf, 1989). Another possibility would be that context effects result from unintentional or involuntary explicit memory for new associations (Schacter, Bowers, & Booker, 1989). If this interpretation is correct, it remains to be explained why such automatic unintentional recollection cannot operate on new verbal material in some amnesic patients (Mayes, 1992). In addition, Cermak, Blackford, O'Connor, and Bleich (1988b) found that even a severely amnesic encephalitic patient did show intact context effects, i.e., context effects in the Graf and Schacter's paradigm can occur without explicit memory of a previous episode.

Few studies have been devoted to the effect of normal aging on word-stem completion priming for new associations. Cermak et al. (1988a) found that word-stem completion by normal elderly subjects was not higher in the same-context condition than in the new-context condition. However, the elderly subjects studied by Howard, Fry, and Burne (1991) revealed a priming effect similar to that observed in young subjects only when they were asked to focus on the critical word pairs during the study phase. This study task was self-paced and required the subjects to generate a sentence relating the two words of each pair, and then to judge how difficult it had been to do so. In a less optimal condition requiring the subjects to listen to and then expand sentences containing the two words, age differences in implicit memory for new associations were observed. The results of the final experiment suggested that age deficits on priming for new verbal associations (and also on explicit cued recall for critical

words) could be related to the elaborateness of the associations made during study. The existence of age differences in the less optimal condition could not be attributed either to age effects in intentional retrieval or to awareness, since most subjects mentioned they did not try to recall the word to which the context word has been paired. Moreover, the pattern of age differences in completion priming remained the same even when only those subjects who were aware of a relation between the study phase and the completion test were considered. According to Howard et al., young subjects were able to quickly establish a relationship between the paired-associates even in a non-optimal study condition, whereas the elderly needed optimal conditions to achieve the same results. In conclusion, Howard et al. observed enhanced completion in the same-context condition (in young subjects with both optimal and less optimal study conditions, and in older subjects in the optimal condition only) even though incidental study conditions were used. These results are inconsistent with those obtained by Cermak et al. who observed enhanced completion in the presence of contextual cues only in young subjects, despite the fact that the study conditions were very similar to the optimal conditions used by Howard et al. except for the intentional study instructions used.

The present experiment was designed to re-examine the effects of different types of study conditions on age differences in implicit and explicit memory for new associations. The performance of young and elderly adults in word-completion and cued-recall tasks was compared following two different study conditions (a generation condition and an evaluation condition) designed to induce more or less extensive elaboration at the time of study (see Schacter & Graf, 1986a). In the *generation condition,* used to induce active elaboration, the subjects were asked to generate a sentence relating the words of each unrelated pair. In the *evaluation condition,* the subjects were provided with elaborators: they were shown sentences that included the word pairs and were asked to judge whether the sentence adequately linked the two words to each other. Both study conditions were self-paced and, as in the Cermak et al. (1988a) experiment but contrary to the Howard et al. (1991) procedure, intentional study instructions were used in an attempt to resolve the problem of previous conflicting results.

METHOD

1. Subjects

A total of 64 subjects took part in the experiment. The young sample was composed of a group of 32 subjects, all students at Louvain University (mean age= 21 years; range: 18-24). A second group of 32 subjects, consisting of

people from a high sociocultural and/or educational level (mean age= 64.5 years; range: 60-70) made up the elderly sample. The subjects in each group were randomly assigned to the two study conditions (generation *vs* evaluation: see below), with 16 subjects in each resulting subgroup.

The general verbal aptitude of the subjects was assessed by means of a French version of the Mill-Hill vocabulary test, multiple-choice form. A 2 X 2 analysis of variance (ANOVA) on the individual scores (out of 34) showed that the young subjects did not differ from the elderly (28 *vs* 29.19: $F(1,60)=$ 0.676) and that the subjects in the generation condition did not differ from those in the evaluation condition (28.91 *vs* 28.28: $F(1,60)=$ 2.44). However, as a consequence of the random distribution of subjects in the two study conditions, the interaction proved to be significant ($F(1,60)=$ 6.09, $p<.02$). When studied post-hoc by means of the Newman-Keuls test, this interaction revealed a significant advantage of elderly over young subjects in the generation condition.

2. Material

The basic material consisted of 96 common words. The words chosen were well known, their length was between 6 and 12 letters (mean= 8), the first three letters of each word formed the beginning of at least 10 common words in French dictionaries, and the initial stem was not shared by any other word selected. The words were quasi-randomly paired to make 48 target pairs of semantically unrelated words. We also constructed a set of 24 fillers that were used only on the completion task. Each of these fillers consisted of a context or cue word and a three-letter word stem.

For counterbalancing purposes, the critical 48 pairs were divided randomly into six sets of eight. For each subject, three sets (24 pairs) appeared in the study list and were later used on both the completion and cued-recall tests. The other three critical sets were not presented on the study list and appeared only in the completion test.

In the completion and cued-recall tests, the material was composed of 72 stems. Twenty-four of these stems were part of the second word in one of the study-list pairs: eight stems were presented alone *(no-context condition),* eight were associated with a new context (i.e., an unstudied word: *new-context condition),* and eight were associated with their study-list cue *(same-context condition).* Twenty-four of these stems were part of the second word in one of the pairs in the unpresented sets: eight stems were presented alone and 16 were associated with their cue word. These items served to measure the baseline, i.e., the probability of generating the studied word by chance. Finally, 24 filler stems associated with a context word were also presented. The experiment was

counterbalanced so that each set appeared equally often in each of the experimental conditions.

For the evaluation condition, 48 sentences were generated which semantically linked the two words of each pair. Eight additional sentences were used as filler items for the study stage.

3. Experimental design and procedure

The design involved two between- and two within-subject variables. The between-subject variables were age (young *vs* elderly) and study condition (evaluation *vs* generation of sentences), with 16 subjects in each subgroup. The within-subject variables were the kind of memory test (implicit or indirect: completion of stems, *vs* explicit or direct: cued recall) and the type of context (same *vs* new vs no context), with eight items in each subcondition. The experiment ran in four stages, in the following order.

The subjects were first enrolled for the **study stage**. Subjects assigned to the *generation condition* were shown a series of 35 pairs of written words, one at a time, and were asked to generate a sentence in which the two words would be semantically related. The series comprised 24 critical pairs of words, plus four additional pairs at the beginning and four at the end to avoid primacy and recency effects, as well as three practice pairs as examples (these 11 pairs were not tested in the following stages). Subjects in the *evaluation condition* were shown a series of 35 written sentences (including three practice sentences and eight fillers for removing primacy and recency effects). In each sentence, the two critical words were written in boldface and underlined, and the subject was asked to state, on a five-point scale, to what extent the sentence adequately linked the two words semantically. In both study conditions, the display of items was self-paced and the subjects were instructed that their memory for the target pairs would be probed at some later point in the experiment.

Then, the subjects performed two tasks that were introduced as unrelated to the main task but designed to study lexical access. However, as a matter of fact, one of them (the second) was the main measure of **implicit memory** in the present design. In the *first task,* subjects were given three minutes to generate the names of as many European cities as possible, in alphabetical order. The *second task* was the stem-completion test. The subjects were given 72 stems: 24 fillers, 24 critical stems (8 stems in the no-context condition, 8 stems in the same-context condition and 8 stems in the new-context condition) and 24 "unpresented" stems (baseline condition; eight stems were presented alone and 16 with a context cue). They were asked to complete each stem by "the first word that comes to mind" (in the no-context condition) or to read the first word

of each pair before completing the stem (in the same- and new-context conditions). In this case, the subjects were instructed that the first word might help them to think of a completion but that it was not important whether the word they produced was related to the context word.

The subjects then performed the **explicit cued-recall task.** They were presented with the 24 critical associations of the study stage: for eight items, the stem was presented alone (no-context condition); for eight other items, the stem was presented together with a new word (new-context condition); for the last eight items, the stem was shown together with its associated word from the study phase (same-context condition). Subjects were asked to explicitly remember the target word in each pair studied, given its three first letters.

Finally, the subjects were asked **to answer four questions** translated from Bowers and Schacter (1990, p.406): "What did you think was the purpose of the stem-completion task?", "What was your general strategy in completing the word stems?", "Did you notice any relationship between the words I showed you earlier and the words produced on the stem-completion test?", and "While doing the stem-completion test, did you notice whether you completed some of the stems with the words studied in the earlier list?".

RESULTS

First, the performance in the *baseline condition* of the stem completion task was analyzed. A 2 X 2 X 2 ANOVA was computed on the proportions of completed stems (by the word chosen by the authors), as a function of age group, type of encoding, and as a repeated factor, the presence (out of 16) vs absence (out of 8) of context. The only significant effect was the presence/absence of context ($F(1,60) = 4.95$, $p < .03$): the proportion of encoded items recalled "by chance" was 0.036 when a contextual word was present, and 0.061 for isolated stems.

Given this observation, the individual raw scores on the implicit memory test were weighted by subtracting the corresponding baseline level. For the sake of clarity, percentages will be reported below, although the statistical analyses were computed on raw scores and proportions.

1. Stem completion: implicit memory

For the 24 critical items, the number of stems completed to obtain the encoded word (less the corresponding baseline: see above) was studied as a function of the contextual condition. A 2 X 2 X 3 ANOVA was computed,

where age group and encoding condition were the two between-subject factors, and the type of context (same-, new-, no-context) was the within-subject factor. A significant main age effect occurred ($F(1,60)= 5.274$, $p<.03$) favoring young (25.28%) over elderly subjects (21.07%), as well as a significant main type of encoding effect ($F(1,60)= 10.19$, $p<.0025$) favoring the generation task (26.01%) over the evaluation task (19.59%), and a significant main type-of-context effect ($F(2,120)= 35.58$, $p<.0001$) showing an advantage (Newman-Keuls test) of the same- (34.44%) over the new- (17.83%) and the no-context conditions (17.26%), which did not differ from each other. The only other significant effect was the type-of-encoding X type-of-context interaction ($F(2,120)= 8.934$, $p<.0002$), which is illustrated in Figure 1. The post-hoc analysis of this interaction showed that the main type-of-context effect pertained only to the generation task, that the same-context condition differed only from the no-context condition on the evaluation task, and that the type-of-encoding effect only applied to the same-context condition (no difference between the two types of encoding for the new- and no-context conditions).

Figure 1. Graph of the significant type-of-encoding x type-of-context interaction in the stem completion, implicit memory test.

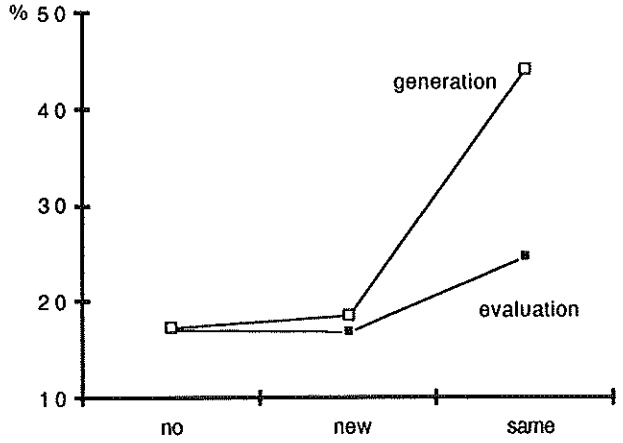

Figure 1. Description de l'interaction significative entre le type d'encodage et le type de contexte dans le test (implicite) de complètement de mots.

2. Cued recall: explicit memory

The same ANOVA was computed on the number of encoded words that were reported in the cued-recall explicit memory task. Once again, the three

main factors reached a statistically significant level. Thus, young subjects (53.39%) performed better than the elderly (31.64%: $F(1,60) = 79$, $p < .0001$), the generation condition led to higher recall (49.22%) than the evaluation condition (35.81%: $F(1,60) = 30.05$, $p < .0001$), and words were better recalled in the same-context condition (65.42%) than they were in the new-context (29.89%) and no-context conditions (32.22%); the last two conditions did not differ from each other ($F(2,120) = 78.89$, $p < .0001$ and Newman-Keuls test). The only other significant effect was the age X type-of-encoding interaction ($F(1,60) = 7.96$, $p < .007$), which is depicted in Figure 2. The post-hoc analysis of this interaction revealed that the main age effect applied to both encoding conditions, but that the advantage of generation encoding over evaluation encoding applied to young subjects only (NS for elderly subjects).

Figure 2. Graph of the significant age x type-of-encoding interaction in the cued-recall, explicit memory test.

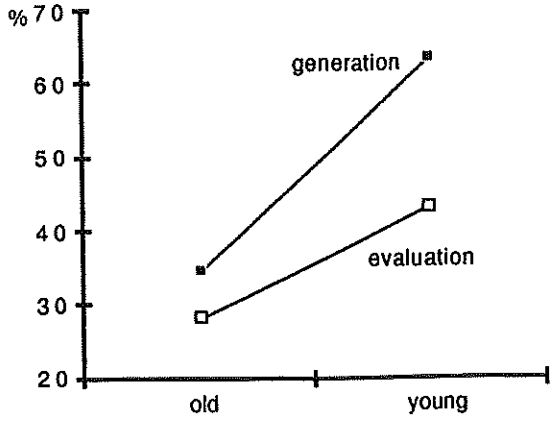

Figure 2. Description de l'interaction significative entre le groupe d'âge et le type d'encodage au test (explicite) de rappel indicé.

3. The post-experiment interview

A completely unaware subject should spontaneously notice no relation between the study phase and the completion test on the first two questions, and should answer "no" to the two other questions (see Bowers & Schacter, 1990). Only two young subjects (both from the evaluation condition) and seven elderly subjects (four from the evaluation condition and three from the generation con-

dition) displayed such a pattern of responses. However, all subjects stated that they continued to follow the completion instructions, i.e., to give "the first word that came to mind".

4. The precision of elaborations during the study phase

The age differences in the completion and cued-recall tests for the generation condition could be due to differences in the quality of the sentences generated by young and elderly subjects during the study phase. To test this hypothesis, we followed the procedure used by Howard et al. (1991), namely, code the precision of the sentences, as defined by Stein, Bransford, Franks, Owings, Vye, and McGraw (1982; see also Stein, Littlefield, Bransford, & Persampieri, 1984). Elaborations were characterized as precise only if they clarified the significance or relevance of the semantic relationship between the two critical words. The generated sentences were rated independently by four judges. Each judge was presented with examples of precise and imprecise elaborations taken from the Stein et al. (1982) paper. Furthermore, some examples drawn from the present experiment were discussed. Inter-rater agreement (Cohen's kappa) reached fair values (in the Fleiss sense, 1981) but never good values. So, an additional criterion was applied: a sentence was categorized as precise or imprecise if at least three of the four judges agreed.

By using this criterion, 194 out of the 256 generated sentences (75.6%) could be categorized (a proportion close to that obtained by Howard et al., 1991). It should be noted that the uncategorizable sentences were equally balanced across the young (mean= 1.94; range: 0-4) and elderly subjects (mean= 1.94; range: 0-3), as attested by the Mann-Whitney non-parametric test (z= -.079, NS). The proportions of imprecise sentences among the categorizable ones was .418 for young and .390 for elderly subjects. The difference was not significant (Mann-Whitney test: z= -.021, NS).

DISCUSSION

Firstly, in all conditions of both tests, the young subjects performed better than the elderly. Secondly, the generation task led to a better memory score than the evaluation task only for the same-context condition in the completion (implicit) test, and only for the young subjects in the cued-recall (explicit) test. Thirdly, the same-context condition led to a better score than the two remaining conditions in each subgroup of the cued-recall test, and in the generation task of the completion test; in the evaluation task, the same-context condition did not

differ from the new-context condition (while differing from the no-context condition).

These results do not replicate those obtained by Cermak et al. (1988a), who found no context effect in elderly subjects in a self-paced generation study condition with intentional study instructions, nor those collected by Howard et al. (1991), who demonstrated no age effect in completion priming in a self-paced generation study condition with incidental study instructions. The age difference in the completion test was observed in the present study even in the optimal generation study condition (and with intentional study instructions) despite the fact that the elderly subjects in this condition showed a significant advantage over young subjects on the Mill-Hill vocabulary test. These age differences do not seem to be the consequence of differences in the precision of the elaborations produced by younger and older subjects, nor in the subjects' ability to deliberately use recollective processes since post-experimental interviews indicated that all subjects followed the instructions, completing the stem with "the first word that came to mind". Nevertheless, it is possible that our rating of the elaboration precision was not sensitive enough to detect significant differences between the young and elderly subjects. Furthermore, it cannot be excluded that the greater effect of priming observed in young subjects could be due to the intrusion of unintentional recollective processes in the completion task.

The present study also showed that completion performance in the same-context condition was better after the generation task than after the evaluation task, and that in the evaluation task, completion in the same-context condition was not better than in the new-context condition. Contrary to what was observed by Schacter and Graf (1986a), it therefore appears that the degree of elaboration of the relationship established between the words during the study phase affects the context effects.

Age differences were found in the new- and no-context conditions. Graf and Schacter (1985; Schacter & Graf, 1986a & 1986b) argued that new- and no-context priming is attributable to automatic activation of pre-existing representations of target words at the time of study. This hypothesis seems to be supported, since priming in both new- and no-context conditions was not affected by the level of elaboration achieved during the study task (evaluation *vs* generation). These age differences in new- and no-context priming are consistent with the recent demonstration of age differences in a single word completion task (Hultsch, Masson, & Small, 1991). However, this clearly contrasts with the fact that severely amnesic patients do not show a stronger priming effect in the same-context condition than they do in the new-context condition, but display intact performance in the new-context condition (Cermak et al., 1988b; Graf & Schacter, 1985; Schacter & Graf, 1986b; Shimamura & Squire, 1989).

Subjects of both age groups showed associative memory in the explicit cued-recall task, since their performance was higher in the same- than in the new- and no-context conditions. Furthermore, subjects in both age groups made use of the instructions to recall since they retrieved more target words on the explicit test than on the implicit test (42.5 vs 23.5%: $t(63) = -11.2$, $p < .0001$), and the young subjects benefited more from these instructions than the elderly (young: 53 vs 26%: $t(31) = -12.6$, $p < .0001$; elderly: 32 vs 21%: $t(31) = -6.7$, $p < .0001$; the pattern of differences is supported by the significant age X kind of test interaction: $F(1,62) = 37.96$, $p < .0001$). Finally, on the explicit test, performance was higher after the generation task than after the evaluation task, but only for the young subjects. A very different effect occurred in the implicit test, same-context condition, where both age groups performed better after the generation type of study than after the evaluation type. Thus, the results show that in elderly subjects the more precise elaboration induced by generation study was sufficient to lead to a contextual effect in the priming completion test (although a lower one than that observed for the young subjects) while this increase in precision, contrary to what occurred for young subjects, was not sufficient to lead to better memory performance in the explicit cued-recall test.

In summary, the present results suggest that reliable age differences in favor of young subjects are observed through the indirect measure of memory for both new associations (even in an optimal generation study condition) and pre-existing representations. They also suggest that the extent of elaboration during the study phase (evaluation *vs* generation) influences implicit memory for new associations in both young and elderly subjects but that, in the older subjects, these processes do not affect explicit memory. The lack of a facilitating effect of the generation condition on explicit memory performance in elderly subjects was also found by Rankin and Collins (1985), who showed that the elderly did not recall more words in sentences when they were given the sentences than when they had to generate the ending of the sentences. On the other hand, the young subjects performed better in the generation condition only when they constructed precise elaborations. The authors concluded that elderly subjects are less likely to generate precise elaborations than the young. Yet, in the present study, we did not observe age differences in the precision of the elaborations generated by the subjects. Rankin and Collins also showed that substantial age-related differences in explicit recall remain, even when older subjects generate precise elaborations.

The existence of elaboration effects on young subjects' performance in both the completion and cued-recall tests suggests that a newly-created episodic representation is involved in both forms of memory (Jacoby & Kelley, 1992; Roediger & Blaxton, 1987). The only difference between explicit and implicit memory may be that implicit memory depends on automatic activation of this

recently created representation, while explicit memory depends on conscious recollection. In that perspective, the present findings could be interpreted as suggesting that the elderly have a specific problem in retrieving new information when deliberate recollection and self-initiated retrieval operations are required (see Light, 1991) and that such a retrieval deficit prevented the older subjects from taking advantage of greater elaboration during study in the cued-recall test. Concerning the deficit shown by the elderly on the completion test, two hypotheses can be proposed: automatic retrieval is affected by age, or the elderly fail to show normal levels of priming for new associations because same-context completion in young subjects is partially mediated by recollective processes.

The present results add to the heterogeneity of those obtained with Graf and Schacter's paradigm in normal (young and elderly) and amnesic subjects. In fact, the memory processes which contribute to poor or normal performance in the Graf and Schacter's paradigm are still not understood. According to Jacoby and Kelley (1992), implicit and explicit memory tasks are probably not pure processes. In other words, implicit memory tasks do not depend solely on automatic memory processes, and explicit memory tests do not depend only on conscious recollection. Consequently, the challenge is to design a procedure which would allow for estimating the extent to which automatic and recollective memory processes are used by subjects in explicit and implicit memory tests. Jacoby and Kelley designed such a procedure: it measures recollection by the difference between performance under conditions in which conscious recollection and automatic processes produce effects in the same direction, as compared with performance under conditions in which the two types of processes act in opposite directions. Such a design should be applied to the Graf and Schacter paradigm to separate automatic and consciously controlled influences in young and elderly subjects (see Mayes, 1992, for a preliminary study using this procedure in amnesic patients).

RESUME

Trente-deux jeunes adultes et 32 personnes âgées ont étudié 24 paires de mots (indice + cible). Ils furent ensuite soumis à un test de mémoire implicite des cibles (complètement des trois premières lettres par "le premier mot qui vient à l'esprit"), puis à leur rappel explicite à partir des indices. Deux types d'étude étaient utilisés, dans un plan inter-sujet : évaluation de l'adéquation d'une phrase contenant les deux mots de la paire, et génération d'une phrase reliant sémantiquement les deux mots. Dans chacun des deux tests de mémoire, le stimulus était associé au même contexte (indice) que lors de l'étude, à un nouveau contexte, ou était présenté seul. Tout d'abord, dans toutes les conditions des deux tests, les performances des sujets jeunes étaient meilleures que

celles des sujets âgés; ensuite, la génération de phrases a conduit à un meilleur score de mémoire que l'évaluation de phrases, uniquement lorsque le contexte initial était représenté au test implicite, et uniquement chez les sujets jeunes au test explicite ; enfin, dans chaque sous-groupe pour le test explicite, ainsi que chez les sujets ayant généré une phrase pour le test implicite, le score était meilleur lorsque le contexte initial était représenté que dans les deux autres cas: chez les sujets ayant simplement évalué les phrases, il n'y avait pas de différence entre le même contexte et un nouveau contexte.

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