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EFFECT OF EDUCATIONAL LEVEL ON CUED RECALL IN YOUNG AND ELDERLY SUBJECTS

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Episodic memory tasks are generally less well performed by elderly than by young adult subjects. It has been suggested that this age effect could result from the lack of spontaneous effective encoding and retrieval strategies, while these strategies are still available as can be shown when encoding cues are provided by the experimenter. In addition, the efficacy of such cues could depend on the subject's educational level. In the present study, young vs elderly subjects, of high vs low educational level, were enrolled in the cued-recall task of 48 items designed by Buschke and Grober (1986). In subjects with a low educational level, it appeared that the cues were insufficient to suppress the differences of performance between elderly and young subjects. More precisely, two main points emerged. Firstly, in highly educated samples, age does not matter much, at least for this kind of memory task. Secondly, with advancing age, the level of education becomes a more important predictor of memory efficiency than age, since the old-low sample performed less well than the other groups in every stage of the test.

Many studies have shown that episodic memory tasks are less well performed by elderly than by younger subjects. These age effects in memory performance are particularly pronounced in tasks involving little contextual support such as free recall of unrelated verbal material. The reason for this, according to Craik and Rabinowitz (1984) and Bäckman, Mäntylä and Herlitz (1990), is that older adults do not spontaneously develop effective encoding and retrieval strategies, despite the fact that they are still potentially able to apply such strategies (the production deficiency hypothesis). In such a perspective, numerous studies have been designed to show that age differences are reduced or eliminated when older people are induced (by the experimenter, the task or the material) to use adequate strategies at the time of encoding and retrieval. In one of these studies, Buschke and Grober (1986) compared the performances of elderly (average age: 81 years) with those of younger subjects (average age: 44.6), by using a cued-recall procedure which, on the one hand, induced a semantic encoding of the material to be remembered and ensured that this encoding was, in fact, carried out, and, on the other hand, provided the subjects with retrieval cues corresponding to the type used at encoding. The authors showed that despite the use of efficient encoding and retrieval strategies, the performances of the elderly, on the whole but with some exceptions, remained lower than those of the younger subjects. Applying the traditional criterion according to which an elderly person is suffering from a memory deficiency if his/her score is more than two standard deviations below the mean of young people, Buschke and Grober showed that only five out of the 14 older subjects displayed normal performances. There were, therefore, only a few elderly people who benefited from favourable encoding and retrieval conditions.

Buschke and Grober (1986) suggested that elderly subjects who have memory difficulties which do not benefit from efficient encoding and retrieval strategies are suffering from genuine memory deficits, i.e. deficiencies which affect the operations of distinct memory processes. These genuine deficits should be distinguished from apparent memory defects resulting from problems affecting other cognitive operations (such as recoding) needed for encoding and retrieval. Apparent but not genuine memory deficits could be eliminated by the control of processing at encoding and retrieval.

This interpretation which makes a distinction, within the different operations undertaken by a subject in an episodic memory task, between distinct memory operations and non-memory processes is in conflict with the hypothesis held by Craik (1985; see also Lockhart & Craik, 1990) according to which it is not necessary to dissociate distinct processes of memorization from those used in perception and comprehension. Indeed, "the memory trace is the by-product of perceptual and conceptual analysis, rather than the consequence of a special memory-encoding process" (Lockhart & Craik, 1990, p. 89). Within this framework, memory is essentially a context-dependent phenomenon and a memory performance can only be understood by taking four sources of variations into account: acquisition variables, test variables, material- and subject-related variables (Bäckman et al., 1990; see also Bäckman, 1989).

On this basis, recent studies have suggested that the efficacy of a contextual support at encoding and retrieval on the memory performance of older subjects could depend on subject variables such as the institutionalization (Winocur & Moscovitch, 1983), the level of education, the verbal crystallized ability, or very old age (Bäckman &

Karlsson, 1986; Craik, Byrd & Swanson, 1987; Dixon, Hultsch, Simon & Von Eye, 1984). It is therefore possible that the individual differences shown by the elderly subjects in Buschke and Grober (1986)'s study were due to some characteristics of the subjects tested. Since the length of formal education can modulate the effect of age on various cognitive tasks (Bornstein & Suga, 1988), the aim of the present study was to investigate whether the length of formal education affects the performance of elderly subjects in a cued-recall procedure similar to that used by Buschke and Grober. Indeed, these authors did not report this individual characteristic of their subjects. Therefore, four groups were compared, in a design crossing two age levels by two educational levels.

METHOD

Subjects

Four groups of subjects participated in the experiment:

— 15 subjects aged between 20 and 25 years (mean = 22.7; 12 females) who had completed an average of 15.9 years of schooling (SD = 0.9): group Young-High.
— 15 subjects aged between 18 and 24 years (mean = 20.3; 1 female) who had left school after an average of 9.4 years of schooling (SD = 1.92) to begin their professional life: group Young-Low.
— 15 subjects aged between 61 and 84 years (mean = 67.9; 8 females) who had completed an average of 14.4 years of schooling (SD = 2.03): group Old-High.
— 15 subjects aged between 60 and 77 years (mean = 66.6; 11 females) who had completed an average of 8.9 years of schooling (SD = 0.9): group Old-Low.

All the elderly people lived at home and claimed to be in good health. To measure the crystallized verbal ability, each subject was administered the Mill-Hill Vocabulary Scale (multiple-choice form; a French language adaptation; Gérard 1983). A 2 (age) X 2 (educational level: high vs low) analysis of variance (ANOVA) computed on the number of correct responses out of 34 showed a significant main age effect ($F(1,56) = 61.5$, $p < 0.0001$) favouring old subjects, and a significant main effect of education ($F(1,56) = 88.5$, $p < 0.0001$), favouring the high over the low level of education, but these results had to be qualified slightly by the significant age X educational level interaction ($F(1,56) = 22.3$, $p < 0.0001$). The post-hoc analysis of this interaction, by applying the Neuman-Keuls test ($p < 0.05$), showed that the advantage of old over young subjects was significant in both levels of education but more important in the low (25.4 vs. 14.13) than in the high level (29.6 vs. 26.8) and, accordingly, that the educational level effect was significant in both age groups but more important for young than for old subjects.

Material

Forty-eight words (target-items) belonging to 48 different semantic categories were selected from the category norms compiled by Dubois (1982) and Masquelier (1988). To avoid guessing in cued recall, the selected target-items were not the most prototypical of their categories, since the first two items mentioned in the norms for each category were excluded. Forty-eight other words which occupied positions close to the latter in the same category norms were also selected. These words were used as distractors at the recognition stage. The mean position of the target-items on the lists was 4.71 (*SD* = 1.2) and that of the distractors 4.77 (*SD* = 2.2).

Procedure

The procedure followed that of Buschke and Grober (1986) and ran in four stages:

Stage 1 : Encoding and immediate cued recall. The 48 target items were presented in sets of four simultaneous items (printed words), and in the same order for all subjects. With the presentation of each set, the examiner orally presented a category cue, for example, "arbre" (tree), and asked the subject to read the corresponding item among the four, for example "poirier" (pear tree). When this procedure had been accomplished for the four items of the set, the examiner took back the card and an immediate cued recall of the four items was carried out: the examiner gave aloud the category cue, and the subject had to recall the relevant item. For items not recalled, the examiner again showed the set and the procedure was repeated for those items. This was followed by another immediate cued recall.

The process was repeated until the four items had been correctly recalled at least once, and then the next set was displayed. This procedure continued until all the items had been covered (12 sets of 4 items). The immediate cued recall was intended to promote a semantic encoding and to ensure that such encoding had really taken place. It was also a practice of recall and ensured that the subject had understood the task (Buschke & Grober, 1986).

Stage 2 : Cued recall of the 48 target-items. Immediately after the first stage, the subject was required to recall all targets, again helped by the cues (the categories) presented in the same order as that used in Stage 1. When the subject was unable to recall, or responded incorrectly, the examiner provided the correct answer. This procedure was carried out twice (Stages 2A and 2B).

Stage 3 : Recognition. The recognition stage was a paired forced-choice test. The examiner presented the subject with two written items, a target and a distractor, belonging to the same category; he also gave the category's name. The subject was required to select the target. The order of presentation of the two items was randomly varied. Before beginning this stage, the subject was informed that he would be given another cued-recall test later, involving the two members of the 48 pairs, and that, therefore, he had to learn the distractors during the recognition test. Ten seconds were allowed for the recognition of the target and the learning of the distractor.

Stage 4 : Cued recall of targets and distractors. Immediately after Stage 3, the subject underwent another cued-recall test, this time with both targets and distractors. This stage tested the ability of the subject in a situation where processing demands were increased by learning during recognition, and encoding (of distractors) was less strictly controlled (than encoding of targets in stage 1).

Results

All the subjects were able to identify the items in the *initial search* of Stage 1. This indicated that the semantic processing induced by the category cue had been correctly carried out.

The results of the four groups for Stages 1, 2A and B, and 4 (targets and distractors) are shown in Table 1. When looking at the

Table, two main points emerge. Firstly, in highly educated samples, age does not matter much. Secondly, with advancing age the level of education becomes a more important predictor of memory efficiency than age. Indeed, the old-low sample performed less well than the other groups in every stage, and scores of the old-high subjects are systematically higher than those of young-low participants and very similar to those of young-high subjects, in spite of the large age range of the old-high group.

Table 1. *The Mean Scores (and Standard Deviations), out of 48, Obtained by the Four Groups for Stages 1, 2 A & B, and 4 (Targets and Distractors)*

	STAGE 1	STAGE 2A	STAGE 2B	STAGE 4 targets	STAGE 4 distrac-tors
YOUNG-HIGH	47.87 (0.35)	44.53 (3.89)	47.73 (0.79)	47.93 (0.26)	43.27 (4.18)
YOUNG-LOW	47.13 (1.64)	42.33 (5.66)	45.40 (3.31)	46.47 (2.85)	30.93 (7.46)
OLD-HIGH	47.67 (0.62)	45.80 (1.32)	47.67 (0.62)	47.93 (0.26)	40.53 (5.15)
OLD-LOW	44.60 (3.50)	35.53 (7.36)	41.00 (5.53)	44.00 (3.82)	20.87 (7.14)

A 2 (age) X 2 (educational level) analysis of variance (ANOVA) was computed on the scores of the four groups in *immediate cued recall (Stage 1)*. Given the initial slight bias between the groups, as observed in the performance in the Mill-Hill test (see above), an analysis of covariance (ANCOVA) was also computed, by taking the Mill-Hill score as the covariate. A significant main age effect appeared ($F(1,56) = 7.25$, $p < 0.01$), but this was not confirmed in the ANCOVA ($F(1,55) = 2.93$, ns.). There was a significant main effect of the educational level ($F(1,56) = 14.01$, $p < 0.001$; ANCOVA: $F(1,55) = 6.01$, $p < 0.02$) favouring the high over the low level. The age X education interaction reached a significant level only in the ANOVA ($F(1,56) = 5.28$, $p < 0.03$; ANCOVA: $F(1,55) = 3.35$, ns.).

The scores for *Stages 2A, 2B and 4 (targets only)* were examined using a 2 (age) X 2 (educational level) X 3 (stages: repeated measure) ANOVA (and ANCOVA). There were significant main effects of age

($F(1,56) = 6.02$, $p < 0.02$; ANCOVA: $F(1,55) = 14.2$, $p < 0.0004$) and of the stages ($F(2,112) = 67.85$, $p < 0.0001$; ANCOVA: $F(2,110) = 3.82$, $p < 0.025$), while the main effect of educational level was significant only in the ANOVA ($F(1,56) = 27.96$, $p < 0.0001$; ANCOVA: $F(1,55) = 1.79$, ns.). There was also a significant age X educational level interaction ($F(1,56) = 8.56$, $p < 0.006$; ANCOVA: $F(1,55) = 16.6$, $p < 0.0001$) and the ANOVA revealed a significant stage X educational level interaction ($F(2,112) = 9.51$, $p < 0.0003$) which was not confirmed in the ANCOVA ($F(2,110) = 1.57$, ns.). However, these effects had to be qualified by the significant educational level X age X stage interaction ($F(2,112) = 6.19$, $p < 0.003$; ANCOVA: $F(2,110) = 6.45$, $p < 0.002$). This interaction was analyzed by means of the Newman-Keuls test, and revealed: (a) an advantage of both high groups over the young-low, and of the young-low over the old-low subjects, for stages 2A and 2B; and (b) that old-low subjects performed less well than the three remaining samples (which did not differ from each other, probably due to the ceiling effect: see Table 1) at stage 4.

The scores of the *delayed recall of targets and distractors (Stage 4)* were examined using a 2 (age) X 2 (educational level) X 2 (stimuli: targets vs distractors; repeated measure) ANOVA (and ANCOVA). Each main factor reached a significant statistical threshold (Educational level: $F(1,56) = 91.35$, $p < 0.0001$; ANCOVA: $F(1,55) = 18.76$, $p < 0.0001$. Age: $F(1,56) = 15.22$, $p < 0.0004$; ANCOVA: $F(1,55) = 20.48$, $p < 0.0001$. Stimuli: $F(1,56) = 329.1$, $p < 0.0001$; ANCOVA: $F(1,55) = 11.49$, $p < 0.002$), but these observations were qualified by the three significant one-way interactions. The age X educational level interaction ($F(1,56) = 6.27$, $p < 0.02$; ANCOVA: $F(1,55) = 12.08$, $p < 0.001$) revealed an advantage of high over low educational level in both age groups (but more important in old than young subjects), and a superiority of young over old subjects for the low educational level only (no age effect for the high educational level). The stimuli X educational level interaction ($F(1,56) = 90.5$, $p < 0.0001$; ANCOVA: $F(1,55) = 27.19$, $p < 0.0001$) revealed a significant educational-level effect for both targets and distractors (but more important for distractors than for targets). Lastly, the age X stimuli interaction ($F(1,56) = 13.65$, $p < 0.0004$; ANCOVA: $F(1,55) = 10.17$, $p < 0.0025$) showed an advantage of young over old subjects for distractors (no age effect for targets, where ceiling effects can be observed in at least three subsamples: see Table 1).

Finally, for the *recognition test (Stage 3)*, the success rate was virtually perfect, since only two errors were made by two subjects in the old-low group.

Discussion

This study shows that the induction of appropriate operations of remembering at encoding and retrieval was not sufficient to cancel the differences of performance between elderly and young subjects, except for the immediate recall test. This statement should be qualified, however. As a matter of fact, contextual support optimized the memory performance of older subjects who had benefited from a longer formal education (old-high). They obtained results equivalent to those of the corresponding group of young people (young-high) in delayed cued recall of targets (Stages 2A, 2B and 4). The elderly subjects with a shorter formal education (old-low) performed less well than all the other groups in every test, with the exception of the recognition test where there was a ceiling effect. Furthermore, the scores of young subjects with a low level of education (young-low) were inferior to those with a high level (young-high) in both phases of stage 2. In the task where the encoding was less well controlled (cued recall of the distractor items: Stage 4), the differences in performance were related to both age (advantage of the young over the old subjects) and level of education (advantage of the high over the low level subjects).

So, two major points emerge from these results. Firstly, in highly educated samples (and for the type of memory task that was used in this experiment), age does not matter much. It is only in less educated groups that age differences emerge. Secondly, with advancing age, the level of education becomes a more important predictor of memory efficiency than age. Indeed, the old-low sample performed less well than the other groups in every stage, and scores of old-high subjects were systematically higher than those of young-low participants and very close to those of young-high subjects, in spite of the large age range of the old-high group.

However, caution is required on two points, and generalization of these observations should not be overestimated. On the one hand, the dispersion of individual scores around the means was higher in old-low subjects than in the remaining samples (see Table 1). Therefore, it is probable that some old-low subjects performed as well as — or even better than — some subjects of the other groups; only statistical comparisons of groups were computed here. In the same vein, it is worth noting that old-low subjects tended to perform better in stages 2B and 4 as compared to stage 2A (even if this effect was not statistically significant). On the other hand, we are aware that the interpretation of ANOVAs and ANCOVAs could be slightly biased since, given the method used, we induced a ceiling effect (and, therefore, a smaller within-group variance) in the first stage of the test than in the other stages.

The effect of educational level on the memory performance of elderly subjects has to be dissociated from the effect of verbal (crystallized) intelligence as measured by a vocabulary test. Indeed, elderly subjects with a low level of education obtained memory scores that were inferior to the three other groups although they obtained vocabulary scores that were equivalent to young and old subjects with a high level of education and superior to young subjects with a low educational level. In addition, it is worth noting that the significant effect of the level of formal education on the recall (in Stages 2 and 4) did not disappear when the vocabulary scores were taken into account as a covariate, which suggests that the level of formal education cannot be simply reduced to verbal crystallized ability.

Other aspects of the results deserve mention. Firstly, unlike the subjects of the three other groups, the old-low subjects did not perform at ceiling level in the first stage of the experiment (immediate cued recall), which suggests the possibility of an encoding deficit. Secondly, despite a low performance in all cued-recall stages (and especially in stage 4), they showed a virtually perfect performance in the recognition phase (stage 3). This indicates that they encoded at least some information about the target items and that their deficit was mainly a retrieval problem. Thirdly, the subjects with a low level of education (and particularly the low-old subjects) showed major difficulties in recalling distractors (stage 4). This suggests that low-level subjects were particularly affected by the increase in the demands of the task (stage 3) where they had at the same time to recognize the targets and to learn the distractors. This deficit in the recall of distractors was still more important for old-low subjects probably due to their possible encoding deficit already mentioned for targets (stage 1).

In conclusion, the present data confirm that the memory performance of the elderly cannot be properly understood unless many different variables, and particularly subject variables, are considered. However, the precise influence of these variables remains to be determined. As to the effect of educational level, it is possible that the subjects with a high level of education spontaneously carried out a more distinctive encoding than that induced by the encoding procedure used in the experiment. They could, for example, have had recourse to the use of personal associations concerning the properties of the items to be memorised (Mäntylä & Bäckman, 1990). A a matter of fact, the task designed by Buschke and Grober (1986) does nor really allow to control the kind of operations that are realized at encoding. Without independent evidence regarding the processing actually carried out by the subjects, there is a risk of circularity in attributing education differences in memory, to differences in type of processing (Salthouse, 1991).

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