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Effects of Perceptual and Conceptual Processing on Memory for Words and Voice: Different Patterns for Young and Old

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In two experiments younger and older adults listened to a list of words presented auditorily by two speakers. The subjects processed each word either perceptually (voice judgements) or conceptually (pleasantness judgements), and were then given memory tasks for the words and the presenting voice. In the word-recognition task the two age groups benefited equally from conceptual as opposed to perceptual processing. In the voice memory task, however, conceptual processing improved performance relative to perceptual processing in the younger subjects (significantly so in Experiment 1), but conceptual processing was associated with decreased performance in the older group (significantly so in Experiment 2). These results suggest that whereas older subjects exhibit a trade-off in memory for item and attribute information, younger subjects exhibit a pattern of support, in which conceptual processing benefits memory for both items and their attributes.

It is clear that experienced events have many different aspects or attributes—their temporal, spatial, perceptual, and semantic qualities, for example—and it has been suggested by several theorists (e.g. Bower, 1967; Underwood, 1969) that the memory encodings of these events must also contain a variety of qualitatively different attributes. How are such encoded attributes formed? A processing view of memory (e.g. Craik & Lockhart, 1972; Kolers, 1973; Kolers & Roediger, 1984) holds that qualitatively different encoding operations process the different aspects of an event and that the resulting representation will reflect these aspects according to the extensiveness of the respective processing operations. A related question concerns the relations among processed attrib-

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utes: Are attributes encoded and retrieved independently, or does the presence of one type of information help or hinder encoding and retrieval of other types?

At encoding, the answer to this question may depend simply on the types of processing carried out, whether induced by orienting tasks or performed spontaneously by the participant. The existing evidence suggests a trade-off between different types of encoding, such that emphasis on one type decreases the likelihood of the encoding of other types. For example, both Bransford, Franks, Morris, and Stein (1979) and Fisher and Craik (1977) showed that an emphasis on semantic encoding reduced the effectiveness of phonemic or structural cues in a later test; the converse was also demonstrated.

At retrieval, the effects of encoded attributes on memory will depend on the compatibility between their qualitative nature and the qualitative demands of the memory test in question (Morris, Bransford, & Franks, 1977; Tulving & Thomson, 1973). Relatively little information exists, however, on whether different aspects of an encoded event facilitate or interfere with each others' effects. Craik, Moscovitch, and McDowd (1994) found effects of a perceptual attribute (visual as opposed to auditory encoding) but no effects of a conceptual attribute (pleasantness ratings) on implicit word-stem completion. When the same stimuli were used but the test changed to explicit word-stem cued recall, the conceptual manipulation had a large effect on performance, yet the perceptual effect remained as large as previously. This result suggests that the encoded attributes were drawn on independently as a function of test demands. Another retrieval effect concerns the reinstatement of initial surface form: Several studies have shown that recognition memory for spoken words is slightly enhanced when the words are re-presented at test in the original voice (Craik & Kirsner, 1974; Goldinger, Pisoni, & Logan, 1991), suggesting that the perceptual information augments other types of item information (lexical, conceptual) in mediating word recognition.

The present study is concerned with the effects of perceptual and conceptual processing on subsequent memory for words and their perceptual attributes. Words were presented in one of two voices and later presented for recognition in either the same or in the alternate voice. Recognition memory for words was the main focus of the study from the subjects' point of view, so in all conditions subjects knew that their memory for the presented words would be tested later (i.e. intentional learning); but we also tested subjects' memory for the initially presenting voice, and in this case memory was incidental. In order to enhance the encoded perceptual and conceptual attributes, respectively, the words were presented with either a perceptual orienting task (voice judgement) or a conceptual orienting task (pleasantness rating). On the assumption that enhanced attributes would boost performance on the recognition test that stressed that type of information, we expected that voice recognition would be enhanced by the perceptual orienting task and that word recognition would be enhanced by the conceptual orienting task. Furthermore, it seemed reasonable to expect that reinstatement of the original presenting voice at test would boost voice recognition (relative to presentation of the word at test in the alternative voice), but that such reinstatement would have a comparatively small effect on word recognition (Craik & Kirsner, 1974; Craik et al., 1994).

These expectations may require some modifications, however. Recent data by Hayman and Rickards (1995) have shown that recall of presentation modality was increased substantially following a semantic orienting task compared with a structural orienting task. In their experiments, words were presented either visually or auditorily and in conditions associated with high or low levels of meaningfulness. In three experiments the researchers found that modality recall was strongly enhanced in the high-meaningfulness condition. Hayman and Rickards concluded that whereas information about modality may be held in a sensory-specific perceptual representational system, PRS (Tulving & Schacter, 1990), it is also held in episodic memory, and that conceptual encoding operations enhance recollection of the entire encoded episode, including its sensory or surface aspects. The study thus demonstrates that conceptual processing at encoding can boost later recall of perceptual attributes; this demonstration is obviously in direct contrast to our earlier suggestion of a trade-off at encoding between conceptual and perceptual information.

The second modification to our original expectations concerns adult age-related differences in the pattern of performance. In a recent study by Naveh-Benjamin and Craik (1995), intended to investigate contextual support in word memory, we presented words auditorily in one of two voices and asked subjects to rate either voice quality or pleasantness of the words at encoding. We looked at memory for voice and found, unexpectedly, that the ability of subjects to recall the original presenting voice was slightly enhanced by pleasantness ratings (relative to voice quality ratings) in the young group, but that for older subjects pleasantness ratings were associated with slightly lower voice recall scores.

There is thus some support in the literature for the finding that conceptual processing enhances subsequent explicit recollection of perceptual attributes (Hayman & Rickards, 1994; Naveh-Benjamin & Craik, 1995), and some suggestion that this effect holds for younger adults but not for older adults (Naveh-Benjamin & Craik, 1995). For this latter group it may even be the case that conceptual processing is associated with poorer recollection of perceptual (and possibly contextual) attributes, in line with our initial expectation of a trade-off between conceptual and perceptual processing.

The present experiments were therefore carried out with several goals in mind. First we wished to explore further the effects of perceptual and conceptual orienting tasks at encoding on later memory for words themselves and for the voice of initial presentation. Second, we examined the effects of reinstatement of the original presenting voice at the time of the memory test on both word recognition and voice recognition. Third, and most importantly, we wished to obtain evidence concerning the possibility that whereas conceptual processing enhances the recollection of perceptual attributes in younger subjects, this effect does not hold (or is even reversed) for older adults.

EXPERIMENT 1

Method

Subjects

Subjects were 20 younger and 20 older adults. The younger subjects were undergraduate students at the University of Toronto who participated in the experiment as part of their course requirements. The older subjects were participants in a voluntary subject pool; they were residents of the Toronto area who lived independently in the community. The elderly were reimbursed for their travel expenses to the laboratory. Mean age of the young subjects was 21 (SD = 2.9), and the mean age of the elderly was 72 (SD = 6.5). Numbers of years of formal education were similar for the young and old (mean young = 14.1; mean old = 15.3). In addition, all the elderly subjects reported that they were in good to excellent health and possessed good hearing.

Design

For the word and voice recognition tests, three independent variables were used: one was age (between subjects), and the other two were type of processing required at study (conceptual versus perceptual), and voice in which the word was presented at test (same versus different to study voice). The latter two variables were manipulated within subjects.

Materials

The study phase included presentation of 68 words via tape-recorder. The first 12 served as practice. Of the next 56 trials, 8 words (4 at the beginning, and 4 at the end) were used as buffers. The remaining 48 words served as the experimental words. Half of the words were presented in one female voice, and the other half in a different female voice. Voices occurred in random order, so that each word was spoken unpredictably by one voice or the other. Two different word orders were employed, and within each order two versions were prepared in which each word appeared in either Voice A or Voice B. Previous pilot work had demonstrated that the voices were distinct from each other. The words were high-frequency two- and three-syllable nouns taken from Kucera and Francis (1967).

Procedure

Subjects, who were tested individually, were asked to listen to a list of spoken words. They were told that we were interested in evaluating their ability to make judgements about one of two aspects of each of the presented words. One judgement concerned the voice, A or B, in which a given word was presented. The other involved rating the pleasantness of the meaning of the word on a scale of 1 through 5 (where 1 = very unpleasant and 5 = very pleasant). Subjects were also told to try to memorize the words in preparation for an upcoming memory test on the words. All subjects in both age groups here, as well as in Experiment 2, indicated in a post-test questionnaire that they expected a word memory test but not a voice memory test.

The experiment started with 12 practice words in order to familiarize the subjects with the procedure. The list was recorded at a rate of one word every 5 sec. During presentation, subjects had to make either a voice judgement—they had to judge for each word whether it was spoken in voice A or B—or a pleasantness judgement, which they had to write at the appropriate place on the response sheet. Subjects knew which was the required judgement for each word by the information provided in the next space on the response sheet: The letters A and B indicated voice judgement, and numbers 1 through 5 indicated pleasantness judgement. During the first 4 practice trials, the experimenter stopped after each word and allowed the subjects enough time to make the judgement. She then corrected any errors they had made and proceeded with the next 8 practice trials, which she ran sequentially without a stop. At the end of practice, subjects were asked whether they had any questions, and then they proceeded with the next 56 words without a stop.

After the end of the study phase, subjects had to count backwards by 3s for 2 min as an interpolated activity. Then the recognition memory test for both item and voice memory was administered in the following way: Subjects listened to 84 words (48 target words and 36 distractors). Of the 48 targets, 24 were spoken by the original speaker (who recorded the words again), and 24 by the other speaker; in each set of 24, 12 words had been processed perceptually (voice judgement) and 12 had been processed conceptually (pleasantness judgement). Of the 36 distractors, 18 were presented by Voice A and 18 by Voice B. For each word presented on the tape, subjects were asked to say "yes" if it had appeared in the study phase and "no" if it had not. In addition, for each word they were asked to write down on the response sheet whether it had originally been presented in the same voice or in a different voice. They were told that even for words to which they answered "no" in the item memory test they should come up with a voice judgement response, indicating which of the voices might have said the word if the words had actually been spoken before. This was done to allow for an uninterrupted sequence of auditory presentation at test.

Results

Study Phase

The young subjects had a higher proportion of correct voice identification (1.00) than the old (.91), $t(38) = 2.21$, $p < .05$. The older subjects had higher pleasantness ratings (3.46) than the young subjects (3.24), $t(38) = 2.67$, $p < .05$, though the distributions of judgements for each age group were fairly similar.

Test Phase

Proportions of hits minus false alarms were calculated for each subject and then averaged over each age group and condition for the word recognition test. For the voice test, performance was also assessed separately for words that had been processed perceptually or conceptually, and for words re-presented in the original or in the changed voice. Voice recognition performance was measured for all target words, regardless whether or not they were correctly recognized in the word test. However, given that subjects could achieve 50% performance by chance, the proportions shown in Table 2 are corrected for chance guessing by the formula:

$$\text{Corrected proportion} = \frac{\text{Obtained proportion} - .5}{1 - .5}$$

Word Recognition. Table 1 shows proportions of hits minus false alarms for each age group as a function of the type of processing employed at study and the voice presenting the words at test (same versus different). As the table indicates, word recognition was higher for young (.58) than for old subjects (.37). In addition, word recognition was higher following conceptual (.62) than perceptual processing (.33). A three-way ANOVA on the hits minus false alarms measure with age, type of processing at study, and voice at test (same versus different) as the variables showed the effects of age and type of processing to be significant, $F(1, 38) = 21.7$, $p < .01$; and $F(1, 38) = 58.2$, $p < .01$, respectively. The interaction effect was not significant, $F(1, 38) = 0.81$, n.s. The effect of voice (same versus different), $F(1, 38) = 0.70$, and the interactions of voice with the other variables were not significant (all $p > .10$).

TABLE 1
Word Recognition for Each Age Group as a Function of Type of Processing at Study and Voice at Test[a]

		Subject Group			
		Young		*Old*	
Type of Processing at Study	*Voice at Test*	*M*	*SD*	*M*	*SD*
Perceptual (Voice)	Same	0.42	0.19	0.26	0.20
	Different	0.41	0.20	0.23	0.20
Conceptual (Pleasantness)	Same	0.76	0.15	0.50	0.29
	Different	0.72	0.17	0.50	0.26

[a] Experiment 1.
Note: Word recognition: hits minus false alarms.

Voice Recognition. Table 2 shows the mean proportions of hits on the voice test, corrected for chance (0.50) so that the measure ranges from 0.00 (chance level performance) to 1.00. Note that voice recognition was calculated on all target items, regardless of whether or not they were recognized in the item test. As the table indicates, the hits measure shows differences between young (0.12) and old (−0.02). The table also indicates some advantage when semantic processing (0.10) rather than voice processing (−0.01) was employed at study. A three-way ANOVA conducted with age, type of processing at study, and voice at test (same versus different) as the three variables showed a significant effect of age, $F(1, 38) = 7.87$, $p < .01$, and a marginal effect of type of processing, $F(1, 38) = 3.64$, $p < .10$. The interaction between age and type of processing was significant, $F(1, 38) = 4.12$, $p < .05$. The effects of voice type, $F(1, 38) = 0.80$, and its interactions with the other variables were not significant ($p > .10$). Young subjects' voice memory was significantly above chance level, $t(19) = 3.16$, $p < .01$, whereas old subjects' voice performance was not.

Note that the pattern of age differences in voice memory cannot be attributed to the old people's difficulty in distinguishing between the two voices, as reflected in their lower voice identification rates in the study phase. Comparison of voice recognition for old subjects with perfect voice identification at study (14 subjects) with those old subjects with less-than-perfect voice identification at study (6 subjects) revealed no differences, with the latter subjects actually performing somewhat better (−.05 and +.01 for the former and the latter, respectively). In addition, the effects of conceptual versus perceptual processing on voice memory were the same in both elderly groups: Neither old subjects with perfect voice identification at study, nor the other old subjects showed an effect of conceptual versus perceptual processing on voice memory (−.05 and −.04, respectively, for the former group, and +.02 and +.01, respectively, for the latter group).

Post-hoc comparisons using the Newman–Keuls multiple range test indicated a significant increase in young subjects' voice recognition performance in the conceptual relative to the perceptual processing condition at study ($M = .22$ and $.00$, respectively, $p < .05$). There were no significant differences in performance of the older subjects in the

TABLE 2
Voice Recognition for Each Age Group as a Function of Type of Processing at Study and Voice at Test[a]

		Subject Group			
		Young		Old	
Type of Processing at Study	*Voice at Test*	*M*	*SD*	*M*	*SD*
Perceptual (Voice)	Same	0.00	0.24	−0.02	0.23
	Different	−0.01	0.19	0.00	0.24
Conceptual (Pleasantness)	Same	0.20	0.29	−0.03	0.20
	Different	0.24	0.30	−0.01	0.25

[a] Experiment 1.
Note: Voice recognition: hit rates adjusted for chance level.

different processing conditions ($M = -.02$ and $-.01$, respectively). In addition, differences between young and old in voice recognition were significant ($p < .05$) under conceptual ($M = .22$ and $-.02$, respectively), but not perceptual processing at study ($M = .00$ and $-.01$, respectively).

Previous results on voice recognition have shown that performance depends on whether or not the item itself is recognized as old; for example, Craik and Kirsner (1974) found that voice recognition was at chance levels for words that were not recognized. The fact that most values in Table 2 are close to the chance level of 0.00 means that conditionalizing on correct word recognition should make little difference, but for completeness these scores are given. For young–hits (averaging over same and different voices) the values for perceptual and conceptual conditions are 0.06 and 0.26, respectively; for young–misses, the corresponding values are −0.11 and −0.18, respectively. For old–hits, the values are −0.03 and 0.00 for perceptual and conceptual processing, respectively, and for old–misses, the values are 0.01 and −0.07, respectively. That is, for the old group all values fall around the chance level of 0.00, but for young subjects hits are associated with higher positive values than are misses—substantially so in the case of conceptual processing. For young–misses in the conceptual case, the below-chance value of −0.18 suggest a tendency for those subjects to give the wrong voice when they fail to recognize a target word. Only 10% of responses were misses in this condition, however.

Discussion

The results for word recognition are straightforward: Younger subjects showed better item memory than did older subjects; also, recognition was superior following conceptual processing as opposed to perceptual processing. The absence of an Age × Type of Processing interaction means that both age groups improved their performance to the same extent from perceptual to conceptual processing, in line with Light's (1991) observations.

With respect to voice recognition, young subjects outperformed old subjects, in line with results previously reported by Kausler and Puckett (1981a, 1981b). It is not possible to say anything about performance in the voice judgement condition as recognition levels were at chance. In the pleasantness rating condition, voice recognition scores improved significantly relative to the voice judgement condition in the younger group—confirming the results of Hayman and Rickards (1995). However, performance levels did not show a similar increase in the older group, and the reliable Age × Type of Processing interaction confirms the trends obtained in Naveh-Benjamin and Craik (1995).

There were no effects associated with voice reinstatement in either test. In the word recognition data (Table 1) there is a very small tendency for same voice to be associated with higher recognition values than different voice, but the effect is far from significant. Similarly, there is no trace of a voice reinstatement effect in the voice recognition data (Table 2), even in the young/conceptual condition. These negative results are taken up again in the General Discussion.

Whereas younger subjects appear to show a pattern of support between lexical and voice attributes, it is not possible to say much about age differences or similarities in this respect in view of the older group's chance performance in all conditions of the voice test. There are several aspects of the experiment that may have penalized the older group. Specifically, the experiment employed a within-subjects design. This could have had two effects on subjects' performance. First, during study, subjects had to switch frequently from one type of processing to the other. This may have been detrimental to older subjects who might have found the frequent switch difficult, hence hampering their performance. Young subjects, on the other hand, might have taken advantage of these frequent switches, so on trials in which a semantic judgement was required they also processed some voice attributes. This processing spill-over might have contributed to young subjects' voice memory performance under conceptual processing instructions. To rule out these possibilities, in Experiment 2 we used type of processing in a between-subject design for each age group.

Second, at test, subjects in Experiment 1 judged each word for both word and voice recognition. Performing the item memory test first could have affected subjects' responses in the voice test. In addition, having to supply voice judgements to distractors could have confused the old subjects. To overcome these problems, independent sets of words were used for the item and voice memory tests in Experiment 2. In addition, only targets were used in the voice test.

Finally, performance in the perceptual (voice) processing condition in both age groups was low in Experiment 1. In order to increase voice performance, we changed several aspects of the design in the second experiment. First using a between-subjects manipulation of type of processing made it easier for the elderly who could now concentrate more on voice processing in the perceptual processing condition. It also reduced spill-over effects for the young. In addition, in the perceptual processing condition, more directive judgements of voice attributes were required at study for each word. Subjects had both to identify the voice (A or B), as in Experiment 1, and also to rate the pitch of the voice saying a given word. Finally, presentation rate at study was slower, at 8 sec rather than 5 sec per item.

To summarize, in order to avoid the above-mentioned problems, and in order to evaluate the replicability of the patterns of results obtained, in the second experiment the type of processing at study was manipulated between subjects for each of the age groups. In addition, independent sets of words were used for the word and voice memory tests. Finally, larger samples of young and old subjects were used, and two male rather than female voices were employed.

EXPERIMENT 2

Method

Subjects

The subjects were 50 younger and 50 older adults. The younger subjects were undergraduate students at the University of Toronto who participated in the experiment as part of their course requirements. The older subjects were obtained from the same subject pool used in Experiment 1 and reimbursed for their travel as in Experiment 1. Mean age of the young subjects was 21 (SD = 2.7), and mean age of the elderly was 74 (SD = 7.7). Numbers of years of formal education were similar for the young and the old (mean young = 14.2, and mean old = 14.7). In addition, all the elderly subjects reported that they were in good to excellent health and had good hearing.

Design

For both the word and voice recognition tests, three independent variables were used: one was age, the second was type of processing required at study (conceptual versus perceptual), and the third was voice at test (same versus different). The first two variables were manipulated between subjects and the third variable was manipulated within subjects.

Materials

The study phase included presentation of 84 words via tape-recorder. The first 12 served for practice. Of the next 72 trials, eight (four at the beginning, and four at the end) were used as buffers. The remaining 64 words served as the experimental words. Half of the words were presented in one male voice, and the other half in a different male voice. Two different orders were used for the words and two versions were employed in which each word appeared in either Voice A or Voice B. The voices were judged by pilot subjects to be distinct from each other. Each word was spoken unpredictably by one voice or the other. The words were high-frequency two- and three-syllable nouns taken from Kucera and Francis (1967).

Procedure

Subjects, who were tested individually, were asked to listen to a list of spoken words. Half were told that we were interested in evaluating their ability to make judgements about the voices in which the words were presented: first, which voice, A or B, spoke a given word; and second, a judgement about the pitch in which a given word was spoken (on a scale of 1 through 5, where 1 = very low pitch, and 5 = very high pitch). The other half of the subjects were told that we were interested in evaluating their ability to make judgements about the pleasantness of the meaning of each of the words presented. They were asked to rate the pleasantness of each word on a scale of 1 through 5 (where 1 = very unpleasant and 5 = very pleasant). Subjects in both groups were also told to try to memorize the words in preparation for an upcoming memory test on the words.

The experiment started with 12 practice words in order to familiarize the sujects with the procedure. The list was recorded at a pace of one word every 8 sec. During presentation, subjects in the perceptual-voice judgement condition had to make voice and pitch judgements and write these at the appropriate place on the response sheet. Subjects in the pleasantness judgement condition also wrote their judgement at the appropriate place on the response sheet. During the first four practice trials, the experimenter stopped after each word and allowed the subjects enough time to make the judgement. She then corrected any errors they made and proceeded with the next eight practice trials, which she ran sequentially without stopping. At the end of practice, subjects were asked whether they had questions, and they then proceeded with the next 72 words without a stop.

After the end of the study phase, subjects had to count backwards by 3s for 2 min as an interpolated activity. Then the two memory tests were administered auditorily to all subjects: first, the word recognition test and then the voice recognition test. Each word appeared in only one of the tests[1] and each subject received one of two counterbalanced sets of words for each of the tests.

Word Recognition Test. In this test, subjects listened to 48 words (24 targets and 24 distractors). Of the 24 targets, 12 were spoken by the original speaker and 12 by the other speaker. Twelve of the 24 distractors were presented in Voice A and the other 12 in Voice B. For each word presented on the tape, subjects were asked to say "yes" if it had appeared in the study phase.

Voice Recognition Test. In this test, 8 of the words appeared in their original (study phase) voice (4 in each of the voices), and the remaining 8 words appeared in a different voice from that at study (4 words were switched from Voice A to B, and 4 were switched from Voice B to A). Subjects were told to write down on the response sheet, for each word heard, whether it was originally presented in the same voice or in a different voice. They were told to try to indicate eight of each type.

Results

Study Phase

There were no differences either in the mean pitch ratings between young (2.62) and old (2.70), $t(48) = .07$, n.s, or in the pitch rating distributions between the two age groups. Subjects in each age group exhibited similar variability in their pitch judgement across words spoken by a given voice. The young subjects had a higher proportion of correct voice identification (.99) than the old (.92), $t(48) = 2.31$, $p < .05$. In addition, the old subjects had higher mean pleasantness ratings (3.50) than the young, (3.32), $t(48) = 2.45$, $p < .05$.

Test Phase

Several analyses were performed for each subject. As in Experiment 1, for the word recognition test, measures of the proportion of hits minus the proportion of false alarms were calculated for each subject and then averaged over each group. For the voice test, the

[1] Only 40 of the 64 words presented in the study phase were used in the tests reported here. The other 24 words were used in other tests not relevant to the current research.

means of hits adjusted for chance level performance were calculated for each subject and averaged over each age group. The results are presented separately for word and voice recognition.

Word Recognition. Table 3 shows proportions of hits minus false alarms for each age group as a function of type of processing employed at study, and voice presenting the words at test (same versus different). As in Experiment 1, word recognition was higher for young than for old subjects (.67 versus .61, respectively). In addition, the table indicates higher performance following conceptual analysis rather than perceptual analysis at encoding (.81 versus .47, respectively). A three-way ANOVA with age, type of processing at study, and voice at test (same versus different) as the variables showed the effect of type of processing to be significant, $F(1, 96) = 107.5, p < .01$. The effect of age was marginally significant, $F(1, 96) = 2.81, p < .10$, and the interaction effect was not significant, $F(1, 96) = 1.36$ n.s. The effects of voice and all other effects involving voice were not significant (all $p > .10$).

Voice Recognition. Table 4 shows mean proportions of hits adjusted for chance level performance (0.50) for each group as a function of type of processing at study as in Experiment 1. A response in the test was counted as a hit when the subjects correctly responded "same" for same voice, and "different" for different voice. Results indicated better voice memory performance than in Experiment 1, probably due to the changes made to boost voice performance in this experiment. The results show that young subjects recognized voice information better than the old (.19 versus .09, respectively). There were no differences in performance when conceptual rather than perceptual processing was used at study (.15 versus .13, respectively). Finally, whereas young subjects showed an improvement in voice memory recognition from perceptual to conceptual processing at study (.15 versus .23), the older subjects showed reduced performance in this case (.15 versus .03).

TABLE 3
Word Recognition for Each Age Group as a Function of Type of Processing at Study and Voice at Test[a]

		Subject Group			
		Young		Old	
Type of Processing at Study	*Voice at Test*	*M*	*SD*	*M*	*SD*
Perceptual (Voice)	Same	0.50	0.23	0.40	0.21
	Different	0.53	0.18	0.43	0.18
Conceptual (Pleasantness)	Same	0.83	0.20	0.81	0.12
	Different	0.79	0.22	0.79	0.14

[a] Experiment 2.
Note: Word recognition: hits minus false alarms.

TABLE 4
Voice Recognition for Each Age Group as a Function of Type of Processing at Study and Voice at Test[a]

		Subject Group			
		Young		*Old*	
Type of Processing at Study	*Voice at Test*	*M*	*SD*	*M*	*SD*
Perceptual (Voice)	Same	0.16	0.27	0.15	0.21
	Different	0.14	0.25	0.15	0.19
Conceptual (Pleasantness)	Same	0.23	0.23	0.02	0.19
	Different	0.24	0.21	0.04	0.21

[a] Experiment 2.
Note: Voice recognition: hit rates adjusted for chance level.

A three-way ANOVA conducted with age, type of processing at study, and voice at test confirmed these observations. The analysis indicated a significant effect of age, $F(1, 96) = 4.43$, $p < .05$, no effect of type of processing, $F(1, 96) = 0.28$, n.s., and a significant interaction between these two variables, $F(1, 96) = 4.93$, $p < .05$. Note that performance of both age groups was significantly above chance level, $t(48) = 3.30$, $p < .05$ for the young, and $t(48) = 1.97$, $p < .05$, for the old. The effect of type of voice and its interactions with the other variables were not significant (all $p > .10$).

To make sure that the inferior voice memory of old subjects was not due to their lower voice identification rates at study, we compared, as in Experiment 1, voice memory for those old subjects who had perfect voice identification at study (12 subjects) with those old subjects with less than perfect voice identification at study (13 subjects). The results indicated no differences between the two groups (+.15 and +.14, for the former and the latter, respectively).

Post-hoc comparisons, using the Newman–Keuls multiple range test, indicated that young subjects' voice memory performance increased, but not significantly ($p > .10$), when conceptual processing rather than perceptual processing was used ($M = 0.23$ and 0.15, respectively), while older subjects' voice memory performance decreased significantly ($M = 0.03$ and 0.15, respectively, $p < .05$). In addition, differences between young and old subjects in voice recognition were significant ($p < .05$) under conceptual ($M =$ 0.23 and 0.03, respectively), but not under perceptual processing at study ($M = 0.15$ and 0.15, respectively).

Discussion

The data on word recognition (Table 3) confirm the results from Experiment 1 and are in line with previous studies—that is, conceptual processing is more beneficial than is perceptual processing for later recognition, younger subjects are somewhat better than older subjects, and both groups profit to the same extent from the contrast between conceptual and perceptual processing (Light, 1991). It is also noteworthy that age differences are minimal in the conceptual condition, in which beneficial processing at input is followed by a "supportive" recognition test (Craik, 1977, 1986).

The voice recognition results are more interesting. Younger subjects' performance again increased (although not significantly) from perceptual to conceptual processing. Older subjects' performance decreased significantly, however, for the same comparison, suggesting that if their attention is directed to the conceptual aspects of the stimulus, they are less efficient at processing the perceptual aspects. That is, whereas younger subjects exhibit a pattern of support between word and voice information, older subjects show a tradeoff pattern—more attention to the semantic aspects of the stimulus results in less effective encoding of the perceptual aspects.

GENERAL DISCUSSION

The results of the two experiments are quite consistent in all major respects. With regard to word recognition, both experiments showed large beneficial effects of conceptual over perceptual processing at encoding, and smaller effects of aging; younger subjects recognized more words than did their older counterparts, although the age difference was minimal in the conceptual processing condition in Experiment 2 (Young = .81, Old = .80). Arguably, this equivalent performance is related to the supportive conditions of encoding and retrieval in the second experiment (Craik, 1986). However, the interaction between age and type of processing was not significant in either experiment, supporting Light's (1991) argument that older people profit as much as do younger subjects from more favourable encoding conditions. Reinstatement of the same voice at test had no effects on word recognition performance in these experiments. This failure to find an effect is perhaps not too surprising, however, as the effect is quite small in previous studies (e.g. 4% in Craik & Kirsner, 1974).

In the case of voice recognition, younger subjects outperformed older subjects in both experiments, confirming previous findings of age-related decrements in the explicit recollection of non-semantic attributes (Kausler & Puckett, 1981a, 1981b; Lehman & Mellinger, 1984, 1986; Light & Zelinski, 1983; Naveh-Benjamin, 1987, 1990). The beneficial effect of conceptual over perceptual processing was marginal in Experiment 1 and absent in Experiment 2, but, more interestingly, age interacted reliably with type of processing in both experiments. Against our original prediction, reinstatement of voice had no beneficial effect on voice recognition, even when performance was clearly off the floor in Experiment 2. However, this last result is in line with data from Hayman and Rickards (1995, Exp. 3), who also reported no beneficial effect of reinstatement of presentation modality on modality recall.

The result of greatest interest is the interaction between age and type of processing in the voice recognition data (Tables 2 and 4). The present results indicate that conceptual processing at input increases subsequent recollection of sensory attributes, but only in young adult subjects; older adults show either no benefit following conceptual processing, or their recollection of sensory information is impaired. The reliability of these contrasting patterns for young and old subjects is strengthened by relevant results that we spotted in previous studies. Although these studies were not set out to look at the above-mentioned effect, and, indeed, their authors did not refer to these trends, nevertheless there were recurring patterns in line with the interaction effect we reported here.

First, Light, La Voie, Valencia-Laver, Owens, and Mead (1992) reported a study in which younger and older adults either counted syllables or gave pleasantness ratings for words presented auditorily or visually; they were later given an unexpected recognition test for the words and asked to recall the presentation modality of recognized words. In line with the Hayman and Rickards study, Light and colleagues found that the more conceptual processing task (pleasantness rating) was associated with higher levels of modality-recall than the syllable-counting task, but only in the younger group. Table 5A shows the overall results for Experiment 1 in Light et al. (1992); younger participants' recall of modality was enhanced by conceptual processing, but older participants' performance was not improved. Half of the words had previously appeared in a perceptual identification task, and for these words modality recall declined from syllable counting to pleasantness rating in the older group (Table 5B). The Age × Orienting Task interaction was reliable.

Second, a similar pattern of results was reported by Schacter, Osowiecki, Kaszniak, Kihlstrom and Valdiserri (1994) in a study of age differences in source memory. They asked subjects to learn which of 32 sources (photographs of people) had made a specific statement. Each source was associated with one "fictitious fact" (e.g. "John Wayne was a minister before becoming an actor"); subjects were later asked to recall the facts (e.g. "what did John Wayne do before becoming an actor?") and also to identify the source. During the acquisition phase, younger and older adults were asked either to rate the likeability of the photographed source or to rate the believability of the facts. This treatment apparently acted as a perceptual/conceptual manipulation, as is shown by later recall of the facts: The proportions were 0.43 and 0.90 for older subjects, and 0.62 and 0.93 for younger subjects, for likeability and believability ratings, respectively. Table 5C shows the proportions of sources recalled in each encoding condition; although the interaction was not reliable in this case, the more meaningful (believability) condition

TABLE 5
Proportions of Perceptual Attributes or Sources Recalled by Young and Old Subjects as a Function of Encoding Condition

		Syllable	*Pleasantness*	*Likeability*	*Believability*
A. Modality Judgement	Young	.73	.83		
	Old	.65	.64		
B. Modality Judgement	Young	.68	.78		
	Old	.65	.60		
C. Source Recall	Young			.39	.47
	Old			.19	.15

Note: Tables 5A and 5B are based on data from Table 4 in Light et al. (1992); Table 5C is taken from Table 2 in Schacter et al. (1994); see text for fuller details.

was associated with somewhat higher source recall in the young group, but slightly lower source recall in the older group.

What are the mechanisms that could mediate these opposing patterns—a support for the young subjects and a trade-off for the older subjects? Hayman and Rickards (1995) argue that sensory features are maintained separately in different representations; first, in a sensory-specific form in implicit memory, and second in a sensory-independent form in explicit memory. They suggest that sensory features are encoded interactively with other aspects of the studied episode, and that any manipulation that enhances recollection of the original event therefore increases explicit recollection of the episode as a whole.

This account provides an explanation for the beneficial effects of conceptual processing on recollection of perceptual attributes (in young subjects at least); it also permits a dissociation between the explicit recollection of perceptual information and implicit priming effects. Implicit tasks are sensitive to perceptual manipulations (Roediger & Blaxton, 1987; Roediger & McDermott, 1993) and generally show negligible effects of aging (Light & Singh, 1987). Hayman and Rickards' suggestion is also in line with the findings of Light and colleagues (1992) that old and young adults showed equivalent effects of perceptual processing in an implicit task, but that younger adults were more accurate than older adults in explicit retrieval of modality information. It seems then that older adults represent perceptual information in a form that is sufficient to drive implicit tasks such as perceptual identification or word-fragment completion, but that they are impaired in the ability to encode perceptual information interactively with other aspects of the study episode.

Why should older adults show a negative relation between conceptual processing and voice recognition (Experiment 2)? One possibility is that if older subjects have limited attentional resources (Craik & Byrd, 1982), their processing capabilities trade off between encoding perceptual and semantic attributes; in their case, more of one means less of the other, whereas younger adults can make use of conceptual processing operations to bind sensory (and perhaps other contextual) information interactively with other aspects of episodic information. When the older subjects' attention was directed to voice characteristics at encoding, their subsequent voice recognition performance was equivalent to that of the younger adults (Table 4); when they processed conceptually under favourable conditions, their word recognition scores were also equivalent (Table 3). Such results fit conceptions of older adults' deficit in spontaneous processing of information, which can be overcome once their processing orientation is constrained and directed towards relevant information (West & Boatwright, 1983). When attention was directed to semantic aspects, however, the resulting conceptual processing acted to bind voice information to other episodic details in the case of younger subjects but detracted from this form of voice encoding in the case of older adults.

In summary, our results show that older subjects exhibit a tradeoff pattern in their memory for perceptual and conceptual information, whereas younger people show a pattern of support. This overall picture is compatible with the reduced processing resources framework suggested as one of the mechanisms underlying decreased episodic memory performance in older subjects (Craik, 1986). At study, the older people pay attention to and process either perceptual or conceptual information, but not both. Processing one type of information will be at the expense of processing the other type, resulting in good explicit memory for the former type only. On the other hand, younger subjects are apparently able to process both types of information simultaneously, resulting either in the encoding of independent processing dimensions (Weldon, 1991) or, as in the present case, in the enhanced retention of perceptual attributes by concurrent conceptual processing.

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