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Memory for Context and Its Use in Item Memory: Comparisons of Younger and Older Persons

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This study compared memory for words and the font in which they appeared (or the voice speaking them) in young and old participants, to explore whether age-related differences in episodic word memory are due to age-related differences in memory for perceptual–contextual information. In each of 3 experiments, young and older participants were presented with words to learn. The words were presented in either 1 of 2 font types, or in 1 of 2 male voices, and participants paid attention either to the fonts or voices or to the meaning of the words. Participants were then tested on both word and font or voice memory. Results showed that younger participants had better explicit memory for font and voice memory and for the words themselves but that older participants benefited at least as much as younger people when perceptual characteristics of the words were reinstated. There was no evidence of an age-related impairment in the encoding of perceptual–contextual information.

There is a debate regarding the reasons for the poorer memory performance typically found in older people. Hypotheses that have been suggested to explain this deficiency include a deficit in semantic processing, failure of metamemory, a failure of deliberate recollection, or a reduction in processing resources (see Light, 1991, for a review). Some researchers (e.g., Burke & Light, 1981) have suggested that the deficit, which is especially prevalent in episodic memory tasks, is caused by the older person's failure to encode a rich context—a failure to encode the perceptual and conceptual details associated with an event. Such a deficit in the encoding of contextual information could result in a more general and stereotypical, and, thus, less distinctive record of the event.

Regarding conceptual–semantic context, Craik and Byrd (1982) proposed that "an encoded event is less modified by the specific context in which it occurs for the older person" (p. 208). Similarly, Rabinowitz, Craik, and Ackerman (1982) suggested that older adults do not create distinctive, contextually specific encoding of new events. In one of their studies, target words at the study phase were paired with either weak or strong associates. These associates were then used as cues at retrieval. The results indicated that although strong cues at encoding and retrieval helped both young and old participants, weak cues that appeared both at encoding and at retrieval helped only the young participants. The researchers concluded that, if target items are not modified by weak contextual cues, these cues will be relatively ineffective at retrieval, as is the case with older persons.

In her review of the literature on the organization of memory in old age, Light (1992) cautioned that the conclusion that regards older adults as not forming semantic contextually distinctive encodings of new events should be evaluated carefully, for several reasons. First, the above results are not invariably obtained, and there are some conflicting results on this issue (Light, 1991; Puglisi, Park, Smith, & Dudley, 1988). In addition, there is some evidence for the general sparing of conceptual knowledge in older adults, as exemplified by a spared vocabulary (e.g., Hartley, 1988) and the fact that older people's comprehension is affected as much as comprehension in younger participants by specific linguistic context (e.g., Cohen & Faulkner, 1983). Light (1992) summarized her review by suggesting that a distinction should be made between linguistic and nonlinguistic contexts. Although older persons are quite sensitive to the former, they might have problems in encoding and retrieving the latter.

There is, indeed, some evidence in the literature that older adults are not as good as younger adults at recalling information about perceptual–contextual (nonlinguistic) attributes. For example, they show *source amnesia*, that is, they have greater difficulty remembering where they encountered made-up facts (McIntyre & Craik, 1987). They are also not as good at reporting the case in which words were printed (Kausler & Puckett, 1980), the modality in which the information was presented (Kausler & Puckett, 1981a; Lehman & Mellinger, 1984, 1986), or the color in which a word was printed (Park & Puglisi, 1985). Finally, they are also at a disadvantage when trying to remember the sex of a speaker (Kausler & Puckett, 1981b) or the case

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format in which words were presented (Kausler & Puckett, 1981a).

The purpose of this study was to test specifically this perceptual–contextual deficit hypothesis. We wished to evaluate several aspects of encoding and retrieval of perceptual–contextual information by older adults. First, we wanted to replicate the results mentioned above, to show that older adults are relatively deficient in remembering perceptual–contextual attributes. The perceptual attribute that was manipulated was either the voice or the font in which the information was presented. We asked each participant to remember in which of two fonts a given word was presented (Experiment 1), or which of two male voices presented a given word (Experiments 2 and 3).

Second, it should be noted that even if older adults are deficient in such a task, it does not rule out the possibility that they still encode some perceptual voice or font information. Although they may be less able to remember a voice or a font explicitly, they may still use such information implicitly in other memory tasks, such as word recognition. There are two opposing predictions regarding the effects of deficient perceptual–contextual processing on item memory. On the one hand, the results by Kausler and Puckett (1981a, 1981b) can be taken to suggest that if older adults are deficient in their encoding of perceptual–contextual detail, they will not be much helped by such information in item memory. On the other hand, Craik (1983, 1986) claimed that memory is a function of both self-initiated processing and environmental support. According to this position, older adults have problems with self-initiated activity. This implies that although older people have more difficulty reinstating the original context on their own at retrieval, they may still benefit from the environmental support provided by the perceptual–contextual information at test. Indeed, if they are especially reliant on environmental support (Craik, 1983, 1986), older people may benefit more than their younger counterparts when the perceptual context is provided at retrieval.

Finally, the above predictions about age-related differences in the implicit and explicit uses of perceptual–contextual information could be affected by whether the older person's attention is focused on the perceptual context. If older adults are characterized by reduced processing resources at encoding, and a consequent failure to process perceptual–contextual information, such a deficit might be minimized by directing their attention to the perceptual–contextual attributes rather than to the semantic aspects of the information. The question is whether such guidance could help them both in the explicit recollection of perceptual attributes (e.g., font, voice) and the implicit support of item memory.

Two levels of perceptual–contextual support in word recognition were used. First, words were represented either auditorily or visually at the time of test; it is argued that the same-modality case (auditory–auditory or visual–visual) provides a general level of support. The second level of support is a more specific one that entails presenting the original information at test either in the same voice or in the same font as at encoding, or in a different voice or font. Craik and Kirsner (1974) showed that young people are able to use same-voice support at test to help them in word recognition.

Such manipulations of both general and specific perceptual–contextual information and the use of memory tests of both perceptual (voice or font) and item (word) information allow us to evaluate the degree to which older adults are deficient in remembering perceptual–contextual information and the degree to which they are able to use such information to support item memory.

To summarize, in the following experiments, we manipulated the instructions for encoding the information—participants concentrated either on the perceptual aspect (font [Experiment 1] and voice [Experiment 2]) or on the conceptual aspect (pleasantness [Experiment 3]). We also varied the amount of environmental support provided at retrieval (i.e., whether or not intermodality and intramodality changes occurred from study to test). We compared performance of young and old adults on memory for item information (words) and perceptual characteristics (font or voice). Note that in all experiments, participants were given intentional learning instructions to remember the words but that memory for the perceptual–contextual aspects was incidental.

Experiment 1

In this experiment, young and old adults received instructions at the study phase to rate font characteristics of the presented words.

Method

Participants

Participants were 25 younger and 25 older adults. The younger participants were undergraduate students at the University of Toronto who participated in the experiment as part of their course requirements. The older participants were members of a voluntary participant pool and residents of the Toronto area who lived independently in the community. The older participants were reimbursed for their travel expenses to the laboratory. Mean age of the young participants was 21, and mean age of the older participants was 73. Numbers of years of formal education were similar for the young and the old participants (*M* young = 14.5 years and *M* old = 15.1 years). In addition, all older participants reported being in good to excellent health and having good hearing and vision.

Design

For the word and font memory tests, three independent variables were used: age (between subjects), modality of test (auditory vs. visual), and font, which was nested within the visual test (same vs. different). The latter two variables were manipulated within subjects.

Materials

The study phase included presentation of 48 words on index cards. The first 6 words served as practice. Of the next 42 trials, 6 (3 at the beginning and 3 at the end) were used as buffers. The remaining 36 words served as the experimental words. Half of the words were presented in one font type (Monaco) and the other half in a different font type (Avant Garde). The fonts and words were paired randomly. Two different orders were used for the words, and two versions were used in which each word appeared either in Font A or Font B. The fonts were piloted and judged by participants to be distinct from each other. Words were high-frequency two- and three-syllable nouns taken from Kucera and Francis (1967).

Procedure

Participants, who were tested individually, saw a list of words presented sequentially. They were told that we were interested in evaluating their ability to make judgments about the font in which the words were presented. Participants were also told to try to memorize the words in preparation for an upcoming memory test on the words.[1]

The experiment started with 6 practice words, to familiarize the participants with the procedure. The list was presented visually at a pace of 1 word every 5 s. During presentation, participants had to make font judgments—they had to judge whether each word appeared in Font A or B and write these judgments at the appropriate place on the response sheet. During the first three practice trials, the experimenter stopped after each word and allowed the participants enough time to make the judgment. She then corrected any errors they made and proceeded with the next three practice trials, which she ran sequentially without a stop. At the end of practice, participants were asked whether they had questions, and then they proceeded with the next 42 words without a stop.

After the end of the study phase, participants had to count backward by threes for 2 min as an interpolated activity. Then the four memory tests listed below were administered to all participants. The order of the tests was counterbalanced across participants, and each word appeared in only one of the tests. Words that appeared in each font at the study phase were assigned randomly to each of the tests until the allotted number of targets for each test was reached. Distractors were assigned in the same manner to the two word tests.

1. *Visual word recognition test.* In this test, participants received a page with 12 targets and 6 distractors, and they were asked to recognize the words from the study phase. Participants were told to try to circle 12 of the 18 words. Six of the targets (3 in each font) appeared in the same font as in the study phase, whereas the other 6 targets appeared in the other (different) font.

2. *Auditory word recognition test.* In this test, participants listened to 12 words (8 targets and 4 distractors), and for each word presented on the tape they were asked to say yes if the word had appeared in the study phase and no if it had not. Participants were told that 8 of the words were targets and were asked to try to provide 8 yes responses.

3. *Visual font test.* Participants received a page with 8 words, all of which had appeared in the study phase. Four of the words had appeared in their original (study phase) font (2 in each of the fonts), and the remaining 4 words appeared in a different font than in the study phase (2 words were switched from Font A to B, and 2 were switched from Font B to A). Participants were told to write down on the response sheet whether each word had originally been presented in the same font or in a different font. They were told to try to indicate 4 words of each font type.

4. *Auditory font test.* Participants judged for each of the 8 auditorily presented words (all of which were presented in the study phase) whether it appeared in the study phase in Font A or B (they were told that there would be 4 words of each type and were asked to try to provide 4 "A" and 4 "B" responses). Before this test, participants saw 2 neutral words in each of the fonts as a reminder.

After the tests, participants were asked to fill out the posttest questionnaire, in which they were asked about the strategies they used at the study and test phases and the degree to which they complied with the instructions.

Table 1
Word Hits and False Alarms for Each Age Group as a Function of Modality at Test (Experiment 1)

	Modality at test							
	Auditory				Visual			
	Hits		False alarms		Hits		False alarms	
Age group	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Young	.70	.14	.40	.26	.78	.10	.40	.20
Old	.61	.16	.37	.27	.74	.11	.40	.22

Results

Study Phase

There were no differences in mean font identification (100% and 99% for young and old, respectively, $t[48] = 1.27$, *ns*).

Test Phase

The results are presented separately for word and font tests.

Word recognition. Because some of the participants in both age groups did not indicate the suggested number of words as targets (they indicated too many or too few), measures of both proportion of hits and proportion of false alarms were computed for each participant and then averaged over each age group for each test separately. Table 1 shows mean proportions of hits for each age group as a function of modality at test. The table indicates that word recognition was higher for young than for old participants (.74 vs. .67, respectively). In addition, the table indicates higher performance for the same modality (visual) than for the different modality (auditory; .76 vs. .65, respectively). Finally, the table shows that the older participants benefited as much as the young from reinstatement of the same modality at the test phase as at the study phase (the older participants' performance increased from .61 to .74, whereas the young participants' increased from .70 to .78 in the auditory and visual tests, respectively). A two-way analysis of variance (ANOVA) with age and modality at test as the variables showed the effects of age and modality to be significant, $F(1, 48) = 6.15$, $p < .05$, $MSE = .017$, and $F(1, 48) = 15.77$, $p < .01$, $MSE = .018$, respectively. The effect of the interaction was not significant, $F(1, 48) = 0.61$, $MSE = .018$.

Table 1 also shows mean proportions of false alarms for each age group as a function of modality at test. As can be seen, there were no differences between the groups and conditions in this measure. A two-way ANOVA indicated no significant effects of age, $F(1, 48) = 0.01$, $MSE = .059$; modality, $F(1, 48) = 0.27$, $MSE = .058$; or their interaction, $F(1, 48) = 0.28$, $MSE = .058$.

[1] Pilot studies showed that instructions for intentional learning of words were important, because both font/voice and word memory were close to chance-level performance when incidental learning instructions were used.

Table 2
Word Hits for Each Age Group as a Function of Font at Test (Experiment 1)

Age group	Font at test: Different *M*	*SD*	Same *M*	*SD*
Young	.81	.10	.77	.19
Old	.69	.16	.79	.15

Next we looked at the effect of change of font (same vs. different) on performance in the visual word recognition test. Table 2 provides mean hits for same versus different font for young and old (no false-alarm rates could be assigned for each level of font separately). A two-way ANOVA performed on these data showed the effects of age and font (same vs. different) to be nonsignificant, $F(1, 48) = 2.82$, $MSE = .022$, and $F(1, 48) = 0.88$ $MSE = .025$, respectively. The effect of the crossover interaction obtained between font type and age was significant, $F(1, 48) = 4.06$, $p < .05$, $MSE = .025$. Post hoc comparisons showed that only the older participants had significantly better performance when same font rather than different font was used, $t(24) = 2.01$, $p < .05$.

Font memory. Because no distractors were used in the font tests, only one measure, proportion hits, was computed for each participant in each condition. A response in the visual test was counted as a hit when the participants correctly responded *same* for same font and *different* for different font. Likewise, a response in the auditory test was counted as a hit when the participants indicated *Font A* when a word was originally presented in Font A and *Font B* when a word was originally presented in Font B.

Table 3 shows mean proportions of hits for each age group as a function of the modality of the test. The results show that there were differences between young (.62) and old participants (.55) in the mean proportion hits. There were no differences when modality of the test was visual (.58) rather than auditory (.59). A two-way ANOVA conducted with age and modality of test as the two variables indicated a significant effect of age, $F(1, 48) = 4.13$, $p < .05$, $MSE = .015$. There were no significant effects of modality and the interaction of age with modality, $F(1, 48) = 0.88$, and $F(1, 48) = 0.97$, respectively ($MSE = .013$). Performance of both age groups was significantly above chance level (.50), $t(24) = 4.76$, $p < .01$, and $t(24) = 1.89$, $p < .05$, for young and old participants, respectively.

Table 3
Font Hits for Each Age Group as a Function of Modality at Test (Experiment 1)

Age group	Modality at test: Auditory *M*	*SD*	Visual *M*	*SD*
Young	.61	.17	.63	.15
Old	.57	.18	.53	.17

Together, the results of this experiment indicate that the older participants' explicit memory for perceptual–contextual information (font) is deficient relative to that of young participants'. This result is similar to that reported by Kausler and Puckett (1981a), who showed better case format memory for young participants. Word memory, however, showed a different pattern. Although older participants had a lower proportion of correct hits, they showed at least as much support by context as did the younger participants. First, older participants improved to the same degree as young participants when the test used the same modality as at encoding. Second, older participants improved significantly more than the young in word recognition when words were presented in the same font versus the different font. Young participants did not show any such effect of font reinstatement at the test.

To increase our confidence in the obtained results, we ran a second experiment in which the following features were changed: First, we replaced font with voice as the specific perceptual–contextual attribute. Two male voices were used instead of two fonts, and participants rated voice characteristics of the stimuli. Modality at test was manipulated as in Experiment 1. Second, to increase the power of the test, we used 64 rather than 36 experimental words, hence, each test included more stimuli (increasing the list's length even more resulted in general decline in performance in both age groups).

Experiment 2

In this experiment, young and old adults received instructions at the study phase to rate voice characteristics of the presented words.

Method

Participants

Participants were 25 younger and 25 older adults. The younger participants were undergraduate students at the University of Toronto who participated in the experiment as part of their course requirements. The older participants were members of a voluntary participant pool and residents of the Toronto area who lived independently in the community. The older adults were reimbursed for their travel expenses to the laboratory. Mean age of the young participants was 21, and mean age of the older participants was 73. Numbers of years of formal education were similar for the young and the old (*M* young = 14.5 years, and *M* old = 15.0 years). In addition, all older participants reported being in good to excellent health and having good hearing and vision.

Design

For the word and voice memory tests, three independent variables were used: age (between subjects), modality of test (auditory vs. visual), and voice, which was nested within the auditory test (same vs. different). The latter two variables were manipulated within subjects.

Materials

The study phase included presentation of 84 words by a tape recorder. The first 12 words served for practice. Of the next 72 trials, 8 (4 at the beginning and 4 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. The presenting voices varied randomly. Two different orders were used for the words, and two versions were used in which each word appeared either in Voice A or Voice B. The voices were piloted and judged by participants to be distinct from each other. Words were high-frequency two- and three-syllable nouns taken from Kucera and Francis (1967).

Procedure

Participants, 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 judgments about the voices in which the words were presented: First, which voice, A or B, presented a given word, and second, in what pitch was a given word spoken (on a scale of 1 through 5, where 1 = *very low pitch*, and 5 = *very high pitch*). Participants were also told to try to memorize the words in preparation for an upcoming memory test on the words. Thus, again, memory for words was intentional, whereas memory for voice was incidental.

The experiment started with 12 practice words, to familiarize the participants with the procedure. The list was recorded at a pace of 1 word every 7 s. During presentation, participants had to make voice judgments—they had to judge for each word whether it was spoken in Voice A or B; they also judged its pitch, and they wrote these judgments at the appropriate place on the response sheet. During the first four practice trials, the experimenter stopped after each word and allowed the participants enough time to make the judgment. She then corrected any errors they made and proceeded with the next eight practice trials, which she ran sequentially without a stop. At the end of practice, participants were asked whether they had questions, and then they proceeded with the next 72 words without a stop.

After the end of the study phase, participants had to count backward by threes for 2 min as an interpolated activity. Then the four memory tests listed below were administered to all participants in a constant order; each word appeared in only one of the tests. Thirty-two words were presented in the word recognition tests, and the other 32 words were presented in the voice memory tests. Words spoken by each voice at the study phase were assigned randomly to each of the tests until the allotted number of targets for each test was reached. Distractors were assigned in the same manner to the two word tests.

1. *Auditory word recognition test.* In this test, participants 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. For each word presented on the tape, they were asked to say yes if the word had appeared in the study phase and no if it had not. Participants were told that half of the words were targets and were asked to try to respond yes to half.

2. *Visual word recognition test.* In this test, participants received a page with eight targets and eight distractors, and they were asked to recognize the words from the study phase. Participants were told to try to circle 8 of the 16 words.

3. *Auditory voice memory test.* Participants listened to 16 words, all of which had appeared in the study phase. Eight 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 than at the study phase (4 words were switched from Voice A to B, and 4 were switched from Voice B to A). Participants were told, for each word they heard, to write down on the response sheet whether it was originally presented in the same voice or in a different voice. They were told to try to indicate 8 words of each type.

Table 4
Word Hits and False Alarms for Each Age Group as a Function of Modality at Test (Experiment 2)

	Modality at test							
	Visual				Auditory			
	Hits		False alarms		Hits		False alarms	
Age group	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Young	.72	.17	.28	.17	.74	.12	.23	.10
Old	.61	.17	.36	.15	.70	.11	.29	.14

4. *Visual voice memory test.* Participants judged for each of the 16 words that appeared on a page (all of which were presented in the study phase) whether the word had appeared in the study phase in Voice A or B. They were told that there would be 8 words of each type and asked to try to provide 8 A and 8 B responses. Before this test, participants listened to the two voices as a reminder.

After the tests, participants were asked to fill out the posttest questionnaire in which they were asked about the strategies they used at the study and test phases and the degree to which they complied with the instructions.

Results

Study Phase

There were no differences in the mean pitch ratings between young (2.82) and old participants (2.84), $t(48) = 0.29$, *ns*. The young participants had higher rates of correct voice identification (.99) than the old participants (.90), $t(48) = 2.72$, $p < .05$.[2]

Test Phase

The results are presented separately for word and voice tests.

Word recognition. As in Experiment 1, not all participants checked the specified number of target words, therefore, proportions of hits and false alarms were calculated for each participant and then averaged over each age group for each test separately. Table 4 shows proportion of hits for each age group as a function of modality at test. Word recognition was higher for young than for old participants (.73 vs. .65, respectively). In addition, the table indicates higher performance for the same modality than for the different modality (.72 vs. .66 for auditory and visual, respectively). Finally, the table shows that the older

[2] Most of this difference was due to a few older participants. There are several indications, however, that this did not affect their memory test performance. First, in the posttest questionnaire, these older participants indicated that most of the errors in voice classification were due to confusion of the voice labels rather than misperception of the voices themselves. In addition, when the data for these participants were analyzed with and without the misclassified words, no differences in performance emerged in any of the memory tests. As a result, the analyses used all of the words.

Table 5
Word Hits for Each Age Group as a Function of Voice at Test (Experiment 2)

Age group	Voice at test: Different *M*	*SD*	Same *M*	*SD*
Young	.75	.18	.72	.15
Old	.71	.15	.68	.14

participants benefited at least as much as the young from reinstatement of the same modality at test as at study (the older participants' performance increased from .61 to .70, whereas the young participants' increased from .72 to .74 in the visual and auditory tests, respectively). A two-way ANOVA with age and modality at test as the variables showed the effects of age and modality to be significant, $F(1, 48) = 4.69$, $p < .05$, $MSE = .029$, and $F(1, 48) = 4.56$, $p < .05$, $MSE = .014$, respectively. The interaction effect was not significant, $F(1, 48) = 2.26$, $MSE = .014$. Post hoc comparisons showed that only the older participants had significantly better performance when the same modality rather than different modality was used, $t(24) = 2.89$, $p < .05$.

Table 4 also presents mean false alarm rates for each age group and condition. The effects here were similar to those obtained for the hits measure. A two-way ANOVA showed significant effects of age (lower proportions for young) and modality (lower proportions in the auditory test), $F(1, 48) = 4.57$, $p < .05$, $MSE = .025$, and $F(1, 48) = 5.85$, $p < .05$, $MSE = .016$, respectively. The effect of the interaction was not significant, $F(1, 48) = 0.24$, $MSE = .016$.

Finally, we looked at the effect of change of voice (same vs. different) on performance in the auditory word recognition test. Table 5 provides mean proportion hits for same versus different voice for young and old participants (no false-alarm rates could be assigned for each level of voice separately). A two-way ANOVA indicated no significant effect of age, $F(1, 48) = 1.58$, $MSE = .030$, of change of voice, or their interaction, $F(1, 48) < 1$, $MSE = .020$, for both.

Voice memory. As in Experiment 1, because no distractors were used in the voice tests, only a proportion of the hits measure was computed for each participant. A response in the auditory test was counted as a hit when the participants correctly responded *same* for same voice, and *different* for different voice. Likewise, a response in the visual test was counted as a hit when the participants indicated *Voice A* when a word was originally presented in Voice A and *Voice B* when a word was originally presented in Voice B. Table 6 shows mean proportion hits for each age group as a function of the modality of the test. The results show that there were almost no differences in hits between young (.56) and old (.55) participants. There were very small differences when modality of the test was auditory (.57) rather than visual (.54). A two-way ANOVA conducted with age and modality of test as the two variables indicated no significant effects, $F(1, 48) = 0.09$, $MSE = .021$; $F(1, 48) = 1.56$, $MSE = .015$; and $F(1, 48) = 0.33$, $MSE = .015$, for age, modality, and their interaction, respectively. Note that performance of both age groups was significantly above chance level (0.50), $t(24) = 2.83$, $p < .05$, for young, and $t(24) = 3.01$, $p < .05$, for old.

Together, the results of this experiment indicate that when the older participants' attention is directed toward processing perceptual–contextual (voice) information, their memory for that information is not deficient in comparison to young participants. This result is different from the one reported by Kausler and Puckett (1981a, 1981b), who showed better voice memory for young participants under intentional learning instructions for voice. In our case, memory for voice was incidental. In addition, the long list made voice recognition a very difficult task; the low scores may obscure an age-related effect.

Word memory, however, was not as good in old as in young participants. Together, young participants showed superiority in their word recognition performance. This advantage was most noticeable in the visual test, where there was no match between modality at study and at test. More important, however, are the results that indicate that old participants can use general context (modality) information as well as (possibly even better than) young participants to support their word recognition, which attests to the relatively preserved encoding of such perceptual information. These results replicate those results obtained in Experiment 1.

Interestingly enough, there was no advantage due to specific perceptual information; neither age group showed an advantage for words presented in the same versus the different voice. These results are different from those obtained by Craik and Kirsner (1974) for young participants. One possible reason for the differences could be the different testing procedures used. In the Craik and Kirsner study, a continuous recognition paradigm was used, whereas in the current study, a study–test procedure was used, which resulted in much longer retention intervals. This, in turn, could have caused the specific voice information to be unavailable by the time of the test (though the same testing procedures used in Experiment 1 resulted in an advantage due to specific perceptual information for older participants).

A possible reason for the older participants' relatively intact memory for perceptual–contextual information in this experiment could be that in this experiment their attention was directed toward voice information. In the third experiment, we tried to assess the degree to which older participants show preserved memory for perceptual–contextual information when

Table 6
Voice Hits for Each Age Group as a Function of Modality at Test (Experiment 2)

Age group	Modality at test: Visual *M*	*SD*	Auditory *M*	*SD*
Young	.55	.16	.57	.12
Old	.53	.13	.58	.11

their attention is directed away from perceptual–contextual information, and whether such diversion of attention would influence the degree to which voice information supports word memory in older adults.

Experiment 3

In the third experiment, young and old participants received instructions at the study phase to rate conceptual characteristics of the presented words (i.e., their pleasantness).

Method

Participants

The participants were 35 younger and 35 older adults. The younger participants were undergraduate students at the University of Toronto. They participated in the experiment as part of their course requirements, or they were paid. The older participants were members of a voluntary participant pool and residents of the Toronto area who lived independently in the community. The older participants were reimbursed for their travel expenses to the laboratory. The mean age of the young participants was 20, and the mean age of the older participants was 72. Numbers of years of formal education were similar for the young and the old (*M* young = 14.3 years and *M* old = 14.7 years). In addition, all older participants reported being in good to excellent health and having no hearing or vision problems.

Design

As in Experiment 2, three independent variables were used for the word and voice memory tests: age (between subjects), modality of test (auditory vs. visual), and voice, which was nested within the auditory modality (same vs. different). The latter two variables were manipulated within subjects.

Materials

The materials used were the same as those used in Experiment 2.

Procedure

Participants were asked to listen to a list of spoken words. They were asked to rate the pleasantness of each word on a scale of 1 through 5 (1 = *very unpleasant* and 5 = *very pleasant*.). Participants were also instructed to memorize the words in preparation for an upcoming memory test. The experiment started with 12 practice trials, to familiarize the participants with the procedure. The list was recorded at a rate of one word every 7 s during which the participants wrote their pleasantness judgment at the appropriate place on the response sheet. The session was then administered in the same manner as in Experiment 2.

After the end of the study phase, participants had to count backward by threes for 2 min as an interpolated activity. Then the four memory tests were administered in the same order as in Experiment 2. Two orders of words were used in each test, and each word appeared in only one test. After the end of the tests, participants were asked to fill out the posttest questionnaire as in Experiment 2.

Table 7
Word Hits and False Alarms for Each Age Group as a Function of Modality at Test (Experiment 3)

	Modality at test							
	Visual				Auditory			
	Hits		False alarms		Hits		False alarms	
Age group	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Young	.91	.09	.10	.13	.92	.09	.10	.11
Old	.86	.10	.18	.17	.89	.09	.12	.13

Results

The results are presented separately for word and voice tests.

Word Recognition

As in Experiments 1 and 2, both proportion hits and proportion false alarms were calculated for each participant. Table 7 shows mean proportion of hits for each age group as a function of modality at test. Performance was higher than in Experiment 2, reflecting the conceptual orienting task used at the study phase. The table also indicates that word recognition hit rates were somewhat higher for young than for old participants (.91 vs. .87, respectively). In addition, word recognition performance was not different when the same modality (auditory) and different modality (visual) were reinstated at test (.90 vs. .88, respectively). A two-way ANOVA, with age and modality at test as the variables, showed the effects of age to be significant, $F(1, 68) = 4.37$, $p < .05$, $MSE = .011$. The effects of modality and of the interaction were not significant, $F(1, 68) = 1.88$, $MSE = .007$, and $F(1, 68) = 0.48$, $MSE = .007$, respectively.

Table 7 also presents mean false-alarm rates for each age group and condition. The effects here were similar to those obtained for the hits measure. A two-way ANOVA showed significant effects of age (lower proportions for young), $F(1, 68) = 4.08$, $p < .05$, $MSE = .024$, but no significant effects of modality or the interaction of age and modality, $F(1, 68) = 1.97$, $MSE = .013$, and $F(1, 68) = 2.33$, $MSE = .013$, respectively.

Finally, we looked at the effect of change of voice (same vs.

Table 8
Word Hits for Each Age Group as a Function of Voice at Test (Experiment 3)

	Voice at test			
	Different		Same	
Age group	*M*	*SD*	*M*	*SD*
Young	.90	.11	.94	.09
Old	.89	.10	.89	.10

Table 9
Voice Hits for Each Age Group as a Function of Modality at Test (Experiment 3)

Age group	Modality at test: Visual *M*	Visual *SD*	Auditory *M*	Auditory *SD*
Young	.49	.16	.61	.12
Old	.47	.12	.54	.11

different) on performance. Table 8 provides mean hits for same and different voice for both age groups. The table indicates no differences in performance between young and old (.92 and .89, respectively) and no differences in the same-voice over the different-voice condition (.92 vs. .90). A two-way ANOVA carried out on these data showed the effects of age and voice to be nonsignificant, $F(1, 68) = 1.65$, $MSE = .016$, and $F(1, 68) = 2.20$, $MSE = .004$, respectively. The effect of the interaction of age and voice showed borderline levels of significance, $F(1, 68) = 3.75$, $p < .06$, $MSE = .004$, indicating a trend for improvement in the young but not in the old when the same voice was reinstated at test.

Note that, although word recognition performance was quite high, these effects are probably not ceiling effects. For both of the above-mentioned word recognition analyses, some of the effects were significant.

Voice Memory

Table 9 shows mean hit rates for each age group as a function of the modality of the test. As in Experiment 2, a response in the auditory test was counted as a hit when the participants correctly responded *same* for same voice, and *different* for different voice. A response in the visual test was counted as a hit when the participants indicated *Voice A* when a word was originally presented in Voice A and *Voice B* when a word was originally presented in Voice B. Performance was generally lower than in Experiment 2, reflecting the diversion of participants' attention at study away from voice information. The results show that there was a difference in hits between young (.55) and old (.51) participants, and there was also an advantage when modality of the test was auditory (.57) rather than visual (.48). A two-way ANOVA, with age and modality of test as the two variables, indicated significant effects for age and modality, $F(1, 68) = 3.99$, $p < .05$, $MSE = .017$, and $F(1, 68) = 20.55$, $p < .01$, $MSE = .014$, respectively. The effect of the interaction was not significant, $F(1, 68) = 1.36$, $MSE = .014$.

Note that, although voice performance level was quite low (especially in the visual tests), the hits measure was sensitive enough to show significant differences for the effects of age and modality. To check the reliability of these results, we tested 40 more participants (20 young and 20 old) in a similar experiment, except for the number of words at study, which was reduced from 72 to 40 to make the task easier. The trends for voice recognition (proportion hits) were very similar to the results reported above, with older people showing the same disadvantage in performance (mean hits of .61 for young and .53 for old).

Together, the results of Experiment 3 indicate that when participants' attention is directed to the conceptual aspects of the information (i.e., pleasantness of words) and away from perceptual–contextual features, the older participants' explicit memory for perceptual information is at a disadvantage: In the voice memory tests, young participants showed an advantage over older participants. Apparently, when older participants' attention is directed toward conceptual encoding, they do not encode perceptual voice information well enough to enable them to remember what voice spoke a particular word.

General Discussion

The results of the three experiments answer, at least partially, some of the questions raised in the introduction. First, older persons are generally deficient in recognizing perceptual–contextual attributes. In all three experiments (and significantly so in Experiments 1 and 3), older participants showed lower performance than the younger ones in their ability to remember either the font or the voice in which a given word was presented. These results agree with previous reports that older adults are deficient in their memory for perceptual context (e.g., Kausler & Puckett, 1981a, 1981b).

There is an indication in the results, however, that memory for perceptual context might have been less deficient in older participants when their attention was explicitly directed to the attribute in question. In Experiment 2, the older participants showed about the same level of voice memory performance as young participants. This result, at first, might appear in contrast to the results reported by Kausler and Puckett (1981a, 1981b), which indicated an advantage of young adults over old adults even when intentional learning for the voice was used. However, one of the problems underlying the older persons' deficiency might be their inability to use appropriate strategies even under intentional learning instructions. When their attention was directed explicitly at more than one specific dimension that underlied voice encoding (voice identification and pitch judgment), as was the case in Experiment 2, they were able to encode perceptual–voice characteristics almost as well as young adults.

Older adults were clearly deficient in memorizing perceptual–contextual attributes of the information when their attention was directed away from these attributes. When their attention was directed toward conceptual attributes, their ability to memorize voice information was inferior to that of young adults (Experiment 3).

Second, although the older participants generally showed lower word recognition performance than the young ones, their pattern of performance in all three experiments indicates that their overall ability to use perceptual–contextual information in supporting their word memory is at least as good as younger participants'. This was especially the case when general context (modality) was used. In all experiments, they showed as much support (increase in performance) as young participants when the modality context was reinstated at test: They improved as much as young participants when the visual modality context was reinstated in Experiment 1 and when the auditory modality context was reinstated in Experiments 2 and 3. Note that, although the interaction of age and modality was not significant in any of the experiments, in all of the experiments word memory performance in the old participants showed a larger support trend than that in the young. Over the three experiments, the mean benefit to older participants of representing words in the same as opposed to the other modality was .08 compared with .03 for younger participants. A two-way ANOVA, with age and modality at test (same vs. different), using participants of all three experiments, indicated borderline levels of significance for the interaction of age and modality, $F(1, 168) = 2.87$, $p < .10$, $MSE = .013$.

Older adults' enhanced performance when the perceptual context (modality) was reinstated at test probably reflects implicit–unconscious influences. In the posttest questionnaire, only 2 participants indicated using the voice/font explicitly at test to help them in the word test, whereas about half of the young participants indicated using such a strategy.

The obtained results are in line with a recent report by Light, LaVoie, Valencia-Laver, Albertson Owens, and Mead (1992) that showed older adults as having as much benefit as young adults in implicit use of perceptual attributes. In their study, older participants showed improved performance in a perceptual identification task to the same degree as young participants when the modality at the study phase and test phase was matched. Their results, however, did not show any gain in word recognition performance by the older participants when the modality at the study and test phases was matched. Our results go a step further in showing such implicit effects of perceptual information not only in implicit memory tests but also in influencing performance on explicit memory tests (word recognition). These results may indicate that although the older participants were deficient in reporting perceptual–contextual details, they still could rely on involuntary access of this information to help them in conscious word recognition.

Such an explanation and the other results reported here are generally in line with the suggestion that the underlying cause for memory deficits in older adults is reduced mental resources (Craik & Byrd, 1982) and that this deficit in mental resources is most disadvantageous when explicit memory tasks are used but less noticeable when the information is used implicitly (Light & Singh, 1987; Park & Shaw, 1992).

Although the picture regarding the use of general modality support in the old is fairly consistent, the data obtained here regarding the use of specific perceptual–contextual information are less clear. On the one hand, results of Experiment 1 indicate that the older participants could use font information more than young participants in word recognition, whereas at the same time their explicit memory for font is clearly inferior to that of the younger participants. Experiment 3, on the other hand, shows an opposite trend in which the young participants showed better use of voice information in word recognition. It could be that the different patterns reflect the use of different perceptual attributes in Experiment 1 (font) and in Experiment 3 (voice). These attributes might influence differentially the support patterns in the young and the old.

The results obtained in the current studies are also compatible with the idea raised by Craik (1983, 1986) that memory is a function of both self-initiated processing and environmental support. Older adults, according to Craik, have problems with self-initiated activity due to reduced processing resources (at the study phase, spontaneously encoding the perceptual information and, at retrieval, reinstating the original context on their own). They could, however, benefit from environmental support either at the study phase or at the test phase (reinstating of the encoding context). At retrieval, when word information is environmentally supported (implicitly) by perceptual characteristics of the stimuli, older adults performed relatively well in comparison to young adults in all experiments.

In summary, the picture that emerges from the current and previous research indicates that complex relationships exist between the effects of age on episodic item memory and on memory for perceptual–contextual information. The present study showed clear age-related differences in memory for the words themselves and also a smaller age-related decrement in memory for the perceptual context. In the latter case, the small effects may be attributable to the difficulty of the task and the consequent depression of scores. Despite these two age-related decrements in explicit memory, however, older participants in all three of the present experiments benefited slightly more than did younger participants when words in the recognition test were represented in their initial form. That is, the older people showed at least as much implicit memory for perceptual–contextual information as did their younger counterparts, even when the perceptual information was used to enhance performance on an explicit memory test.

What implications do these results have for theories of memory and aging? Context can influence memory in various ways. First, different contexts can influence the interpretation of an event, so that the same event can be encoded differently (distinctively) in different contexts. The present experiments do not really address this issue. Second, context can be added to the encoding of an event, thereby enriching the encoding and increasing the event's chance of retrieval, especially if the context is reinstated at the time of test. The present study does address this issue, and results show that older people do encode perceptual–contextual information that they can use at retrieval. Age-related difficulties in episodic remembering, therefore, cannot be attributed to any simple failure of older people to encode the perceptual–contextual form in which events are presented.

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