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5. Effects of Aging and Context-Specificity on Habit and Recollection

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An extension of Hay and Jacoby's (1996) paradigm was used to separate the contribution of habit and recollection to memory performance in young and elderly adults. In an initial training session, participants learned A–B, A–C associations in which stimulus-response strength was manipulated across contexts. The extent to which context-dependent habits were acquired was measured on later memory tests using Jacoby's (1991) process-dissociation procedure. Results showed that habit estimates reflected context-dependent contingencies from training for both young and elderly adults, although older adults did not show as much specificity. In contrast, recollection estimates were not affected by contextual manipulations from training but were affected by age. These findings support the view that automatic and controlled memory processes make independent contributions to performance.
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Rationale

Hay and Jacoby (1996) separated the contribution of habit and recollection to memory performance within a single task. In the first phase of their experiments, participants were exposed to pairs of associatively related words with the probability of the pairings being varied. For example, a stimulus word "knee" was paired with a response word "bend" on 75% of occasions, whereas for the other 25% of occurrences, it was paired with the response "bone." The intention was to build a habit or automatic response in a manner similar to that produced by placing one's keys in the same location on 75% of occasions and in a different location on the remaining 25% of occasions. Once habits were established, the second phase of the experiment created a situation similar to that of remembering where one's keys were left on a particular occasion. Participants studied specific items (e.g., knee–bend or knee–bone) for a cued recall test that followed. At test, participants could respond by recollecting the previously presented item and/or by relying on their habit for the item. Jacoby's (1991) process-dissociation procedure was used to separate out and measure the contribution of habit and recollection to performance. It was found that habit was affected by the "strength" of the pairings in the training session such that habit estimates reflected the probability with which items had been earlier presented. In contrast, recollection did not reflect probabilities from training but was affected by manipula-

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tions of presentation rate at study and amount of time to respond at test, variables that did not affect estimates of habit. A similar dissociation has been found with aging, which produces deficits in recollection while leaving automatic influences intact (e.g., Jennings & Jacoby, 1993).

The purpose of the following study was to extend the findings of Hay and Jacoby (1996) to investigate whether participants could learn context-specific habits. That is, stimulus-response strength was manipulated across different training contexts using identical response words and the effects on habit and recollection were examined. It was expected that habit estimates, but not recollection, would be sensitive to context-dependent contingencies from training. Furthermore, the effects of aging on habit-learning and recollection were examined to determine if older adults were sensitive to context-specific contingencies in a manner similar to the young.

Methodology

Participants. Twenty-four elderly McMaster University alumni (M = 74.8 years) volunteered to participate in the study. Young adults (N = 24) were enrolled in an introductory course at McMaster University and participated for course credit (M = 19.5 years).

Materials. The materials consisted of 10 pairs of responses (e.g., bend/bone) that were differentially paired with each of two context words (e.g., knee and leg). Response words were semantically related to both context words and could be used to complete an identical word fragment (e.g., b_n_). The context words were assigned to either a *strong-habit* or a *weak-habit* condition, counterbalanced across participants. For each context, one response word was designated to be the target response and the other response was the alternative. For the *strong-habit* condition, the target response was presented on 75% of the trials (e.g., knee–bend) while the alternative appeared on 25% of occasions (e.g., knee–bone). For the *weak-habit* condition, the target response was presented on 25% of trials (e.g., leg–bend) while the alternative was presented on 75% of occasions (e.g., leg–bone). Target responses were counterbalanced across participants.

Procedure and design. The first phase of the experiment was a training session designed to create habits of specific strengths. The training session consisted of five blocks of 80 word pairs presented at a 3-s rate. Within each block, the 10 word pairs from each context condition were presented 4 times. The proportion of trials on which target responses were presented was manipulated across the *strong-* and *weak-habit* conditions. In the *strong-habit* condition, each target response was presented 3 times out of 4 (75%) in each training block and the alternative was presented once. For the *weak-habit* condition, each target item was presented 1 time out of 4 (25%) and the alternative was presented 3 times. Across training, each set of word pairs received 20 presentations in each context.

After the training phase, participants received 20 successive study/test lists. Each study list contained 8 word pairs, presented at a rate of 1 s/pair. Memory was tested after each study list by giving participants the context word of each pair along with a fragment that could be completed with either the target response or alternative (e.g., knee–b_n_). Participants were instructed to complete the fragment by recalling the response from the list they just studied and were instructed to guess if they could not remember.

At test, recollection of the target word was congruent (acted in concert) with habit when the word studied in the short list was the target response from training, but was incongruent (acted in opposition) with habit when the studied word was the alternative response. For congruent trials, responding on the basis of habit established in Phase 1, or on the basis of recollection, would produce a correct response. In contrast, on incongruent trials, erroneously completing a fragment with the target response when the alternative item was studied, was a memory slip. Estimates of recollection and habit were derived by combining performance on congruent and incongruent trials with equations from Jacoby's (1991) process-dissociation procedure (for details see Hay and Jacoby, 1996).

Results

The significance level for all tests was set at $p < .05$. Using the equations from the process-dissociation procedure, recollection was estimated as the difference between the probability of giving a target item as a response on the congruent and incongruent trials within the *strong-* and *weak-habit* conditions separately. Analysis of recollection estimates revealed a main effect of age, $F(1, 46) = 14.97$, $MSe = .046$, demonstrating that young adults were better able to recollect than older adults. There was no difference in recollection across contexts, $F(1, 46) = 1.77$, and the interaction did not approach significance, $F < 1$. The process-dissociation equations were also used to derive estimates of habit. A comparison of habit estimates across age and context revealed a significant effect of context such that estimates were higher in the *strong-habit* condition versus the *weak-habit* condition, $F(1, 46) = 70.82$, $MSe = .015$, but habit estimates did not differ between young and elderly adults, $F < 1$. The interaction between age and context was marginally significant, $F(1, 46) = 3.39$, $MSe = .015$, suggesting that habit estimates for older adults were less context-specific compared to young adults. Estimates of recollection and habit for young and elderly adults are presented in Table 1.

Discussion

The results revealed that young and elderly adults were able to acquire context-specific habits that reflected associations they had learned during training. These findings demonstrate that automatic influences of memory

TABLE 1
Estimates of Habit and Recollection by Age and Context Condition

	Recollection		Habit	
	Strong-habit context	Weak-habit context	Strong-habit context	Weak-habit context
Young	.47	.52	.64	.38
Elderly	.32	.33	.56	.40

expressed as habit remain intact in older adults. However, the extent to which context-specific habits were acquired differed with age in that young adults showed more specificity than did the older adults. Estimates of recollection were not affected by contextual manipulations from training but did show a significant decline with age. Our results converge with other studies using the process-dissociation procedure (e.g., Jennings & Jacoby, 1993) that have shown age-related deficits in recollection in the presence of preserved automatic responding. Dissociations such as the ones reported here support a model of memory in which automatic and consciously controlled memory processes make independent contributions to performance.

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6. Attention Orienting in a Spatial and a Nonspatial Task by Healthy Young and Elderly Subjects and by Alzheimer's Disease Patients

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Attention orienting in a spatial (the Posner type) and a nonspatial (the Stroop type) task was examined in healthy young, healthy elderly, and patients with Alzheimer's disease (AD). The designs of the two tasks were comparable in terms of cue type, cue validity, and cue-to-target SOA. The effect sizes (Hedge's *g*) derived from the cost-plus-benefit measures of cue validity were used in the comparisons between