Touron, D. R., Swaim, E., & Hertzog, C. (2007). Moderation of Older Adults' Retrieval Reluctance Through Task Instructions and Monetary Incentives. ***Journal of Gerontology: Psychological Sciences**,* 62(3): 149-155. Published by the Gerontological Society of America (ISSN: 1079-5014).

Moderation of Older Adults' Retrieval Reluctance Through Task Instructions and Monetary Incentives

Dayna R. Touron, Elizabeth T. Swaim, and Christopher Hertzog

ABSTRACT

Previous research using a noun-pair lookup task indicates that older adults delay strategy shift from visual scanning to memory retrieval despite adequate learning, and that this “retrieval reluctance” is related to subjective choice factors. Age differences in spontaneous response criteria, with older adults valuing accuracy and young adults valuing speed, might account for this phenomenon. The present experiment manipulates instructions and reward contingencies to test the flexibility of response criteria and strategy preferences. Task instructions conditions equally focused on speed and accuracy, encouraged retrieval use as a method toward fast responding, or offered monetary incentives for fast retrieval-based performance. Results indicate that older adults in the incentives condition shifted to retrieval earlier than those without incentives, bolstering the argument that reliance on retrieval is volitional.

AGE differences in associative learning and skill acquisition are well documented in a variety of task domains and experimental paradigms (Bosman & Charness, 1996; Kausler, 1994; Naveh-Benjamin, 2000; Siegler & Lemaire, 1997; Strayer & Kramer, 1994). Older adults show more shallow learning curves with lower overall acquisition than do younger adults (Hoyer, Cerella, & Onyper, 2003; Rogers, Hertzog, & Fisk, 2000; Touron, Hoyer, & Cerella, 2001, 2004). Age differences are particularly pronounced for skill-acquisition tasks that involve a transition in response method, or strategy shift, from performing an algorithm to retrieving solutions directly from memory (e.g., Logan, 1988; Rickard, 1997). Strategy shift by older adults is generally slower and less complete than strategy shift by young adults (Hoyer et al.; Rogers & Gilbert, 1997; Rogers et al.; Touron et al.).

Although age-related declines in associative learning are substantial (Kausler, 1994), an associative learning deficit does not fully account for age differences in performance changes with practice (Touron & Hertzog, 2004b). Strategic behavior and resource utilization also play a critical role. Thus, age differences in rates of acquiring new skills may also be influenced by factors such as strategic behavior, beliefs, and motivation (Kanfer & Ackerman, 1989).

Older adults expect memory declines to occur with aging, and they do not expect such changes to be controllable (Hertzog & Hultsch, 2000; Lineweaver & Hertzog, 1998). Moreover, older adults' implicit theory that aging causes memory decline apparently influences the belief that one's own memory has declined, which may distort estimates of how much decline one has experienced (McDonald-Miszczak, Hertzog, & Hultsch, 1995). As a consequence, older adults may have a low level of confidence in their ability to employ memory effectively when demanded by a cognitive task, even when they are capable of doing so.

Indeed, older adults with low confidence in their ability to use the memory retrieval strategy avoid shifting to it in the noun-pair (NP) lookup task (Touron & Hertzog, 2004a, 2004b). In the NP task, participants verify whether a centrally fixated target NP also appears in a lookup table shown at the top of the display (Ackerman & Woltz, 1994). NPs are consistently mapped (Shiffrin & Schneider, 1977)—that is, do not change from trial to trial—to allow learning of the associative pairings. Discrimination of matched from unmatched pairs can be achieved by either visual search of the lookup table or, after incidental learning by means of repeated exposure, by memory retrieval.

One can measure shift to retrieval strategy use by using strategy probes following each NP trial. Strategy reports in such skill-acquisition tasks are valid reflections of strategy implementation (see Hoyer et al., 2004; Rickard, 2004; Touron, 2006; Touron & Hertzog, 2004b; Touron et al., 2004). To compare reported retrieval strategy use with memory retrieval ability, we couple strategy reports with recognition memory trials, in which the table is not displayed and responses must be based on memory retrieval (Touron & Hertzog, 2004a, 2004b). Comparison of retrieval reports and recognition performance demonstrates that older adults are less likely than young adults to utilize a memory-based strategy, even when sufficient NP memory is available to allow effective use of the retrieval strategy. Individuals can behave adaptively by tailoring strategies to match affordances of specific task contexts (Schunn & Reder, 2001). In contrast, older adults' reluctance to use the retrieval strategy appears to be maladaptive because it may cost potential improvement in response efficiency.

Touron and Hertzog (2004a) jointly manipulated list length (i.e., the number of stimuli to be learned) and display size (i.e., the number of stimuli in to be searched in the lookup table) to affect the relative affordance of performing the NP task by means of visual search versus memory retrieval. When it was relatively efficient to use visual search instead of shifting to retrieval (long list, small display), older adults appeared especially reluctant to shift to retrieval. However, when conditions afforded the retrieval strategy (short list, large display), older adults increased retrieval use with practice, approaching the level of younger adults' strategy shift. Such findings indicate that older adults do respond to the relative costs and benefits of the two strategies. Individuals may engage in an implicit or explicit cost–benefit analysis regarding the effort expenditure and performance reward for each strategy. If so, the subjective costs and benefits for the two strategies may differ between older and younger adults. Older adults may typically consider the visual search strategy to be less costly and more beneficial than retrieval from memory.

Older adults are often more conservative than young adults in response time (RT) task response criteria (Brebion, 2001; Desrocher & Smith, 2005; Hertzog, Vernon, & Rypma, 1993; Ratcliff, Spieler, & McKoon, 2000; Salthouse, 1979), preferring accuracy over speed. They continue to accumulate evidence about the discrimination after a correct judgment would already be possible, based on the evidence already gathered (Thapar, Ratcliff, & McKoon, 2003). It is uncertain to what degree older adults' retrieval reluctance in the NP task is under volitional control and can therefore be modified. To test the flexibility of older adults' NP strategy use, Touron and Hertzog (2005) manipulated the instructions provided for the NP task. The standard NP task was compared with conditions with instructions that (a) encouraged fast responding, or (b) encouraged retrieval use as a method for fast responding, explicitly encouraging participants to retrieve as soon and as often as possible. Older adults' accuracy bias and retrieval reluctance persisted, despite explicit speed and retrieval instructions.

If age differences in strategy shift were simply the result of a failure to recognize the relative efficiency of retrieval over scanning, instructions should have moderated older adults' retrieval reluctance. An alternative hypothesis is that older adults recognize the performance advantage afforded by retrieval strategy use, but they are insufficiently motivated to act on the basis of that realization. To test this possibility, in the current study we introduced monetary incentives to eliminate the discrepancy between degree of associative learning and retrieval strategy usage.

Although previous research indicates that monetary incentives can effectively enhance performance in younger adults (Honeywell, Dickinson, & Poling, 1997; Shah, Higgins, & Friedman, 1998; Shum, O'Gorman, & Alpar 2004), the benefits of incentives on older adult performance are less clear (but see Birkhill & Schaie, 1975). Strayer and Kramer (1994) found that older adults under monetary incentive still performed more slowly and more accurately than younger adults did in a memory search task, but they did not include a control condition to gauge the fundamental impact of incentives on older adult performance.

In the current study, we examined NP performance by younger and older adults in three conditions, comparing standard NP instructions (Condition 1) with instructions that encouraged retrieval use as a method toward fast responding (Condition 2) or offered monetary incentives for fast retrieval-based performance (Condition 3). We hypothesized that older adults given monetary incentive for retrieval use would shift strategies earlier and more comprehensively than older adults not given monetary incentives.

It is possible that prior failures to manipulate older adults' response criteria in previous studies (Strayer & Kramer, 1994; Touron & Hertzog, 2005) were related to deficient comprehension of emphasis instructions. To protect against this problem, in the current study we quizzed participants on the instructional material for all conditions prior to testing. To address the possibility that participants do not retain an appropriate mental model of the task instructions, we followed the NP task with a mental model questionnaire that surveyed participants' task goals at different stages during task performance.

METHODS

Design

We randomly assigned younger and older adults to the following conditions: (a) control (standard NP instructions that equally emphasize speed and accuracy), (b) instructions (emphasizing quick responding through use of retrieval), and (c) incentives (providing monetary incentives for responding quickly by using retrieval). All participants completed two phases of testing, with Phase 1 containing 30 blocks of standard NP trials and strategy reports and Phase 2 containing 6 blocks of recognition memory probes and confidence judgments.

Participants

We tested 74 young adults between the ages of 18 and 25 years and 64 older adults between the ages of 60 and 75 years. Young adults were University students who participated for extra credit. Older adults were recruited from the community and received a $40 honorarium for their participation. We had all participants prescreened for basic health issues that could impede participation, such as vision problems or arthritis. We assessed visual acuity with the Lighthouse Near Visual Acuity Test (second edition); all participants demonstrated corrected visual acuity of at least 20/50. We collected demographic data and administered a brief cognitive battery for group and condition comparisons. Participant characteristics are provided in Table 1. Age differences, when obtained, were consistent with typical findings. We found no statistically reliable condition differences or interactions with the condition variable ($p > .05$).

Table 1. Means (and Standard Errors) of Participant Characteristics

Measure*	Young	Old
Age	18.79 (0.27)	64.45 (0.71)
Years of education	12.67 (0.27)	16.70 (0.66)
Medications	0.75 (0.22)	2.95 (0.46)
Cognitive ability tasks		
Vocabulary	27.91 (0.59)	35.13 (0.70)
Digit Symbol	63.33 (2.53)	49.21 (1.99)
Digit Symbol Memory	7.52 (0.39)	4.93 (0.47)
Post-test survey		
Global Confidence Rating	84.93 (3.44)	67.62 (4.93)
Average Recall JOL	93.51 (2.42)	72.19 (5.38)
Recall Accuracy	86.77 (3.61)	57.13 (7.38)

Notes: JOL = judgment of learning; Medications = self-reported number of daily medications; Vocabulary = number correct on the Shipley Vocabulary Test out of 40 (Zachary, 1986); Digit Symbol = Wechsler Adult Intelligence Scale Digit Symbol subtest; Digit Symbol Memory = number of symbols correctly recalled (out of 9) following the Wechsler Adult Intelligence Scale Digit Symbol subtest.

*Age main effect is $p < .05$ for all measures.

Materials and Procedures

Following the demographic survey and pretest battery, participants began the computerized NP task. Phase 1, which included 30 blocks of 24 NP trials and strategy probes, was followed by Phase 2, which included 6 blocks of 24 recognition memory probes and confidence judgments. A Visual Basic 6.0 program controlled stimulus presentations and response recordings. We had stimuli presented in 15-point Arial font on a 15-in. (38.1 cm) LCD monitor with a resolution of 1024 × 768. We adjusted seating and monitors to a height and distance that optimized each participant's viewing and comfort.

All participants received general task instructions via computer. Participants in the instructions condition received additional instructions emphasizing quick responses and informing them that the best way to respond quickly is to retrieve the target NP from memory. Participants in the incentives condition received additional instructions about the incentive system, which stated that (a) 1 point worth 50¢ could be gained for each block of accurate memory retrieval for a maximum total payout of $15, (b) the criteria to earn points would become more stringent over time, and (c) their goal should be to eventually achieve 100% retrieval use. Incentives instructions did not provide the precise criteria for receiving points, as this might have led to more vigilant task monitoring that could be resource depleting. Before testing began, we required all participants to score perfectly on a series of review questions confirming their understanding of their condition instructions. If one or more review questions were answered incorrectly, we allowed participants to review the instructions before attempting the quiz again.

In Phase 1, we had participants train on a NP task stimulus set containing 24 semantically unrelated concrete nouns that were randomly paired (e.g., TABLE–APPLE). The target pair was matched (i.e., identical) to one of the pairs in the lookup table for a random 12 of the 24 trials in each block. Unmatched trials paired a left-hand word from one pair with a randomly selected right-hand word from a different pair. We had each pair presented as a target 60 times during the course of training. The pairings in the lookup table did not change, but we randomly rearranged their physical location in the table for each trial. Participants were to press a key labeled “Y” if the target pair was matched in the lookup table or a key labeled “N” if the target pair did not match any pairs in the lookup table. If participants responded to the NP trial incorrectly, the trial was followed by the presentation of the word ERROR in the center of the screen for 1 s. The instructions program then asked participants to report the strategy used by pressing labeled keys: S if they used the scanning strategy, M if they used the memory retrieval strategy, B if they used both strategies, or O (signifying “other”) if they used a strategy not listed herein.

For the incentives condition, the point-based system to earn a monetary bonus included the following criteria. To account for normative performance improvements, we increased the minimum percentage of retrieval trials required to earn bonus points from 50% (Blocks 1–10) to 75% (Blocks 11–20) to 90% (Blocks 21–30). Use of the retrieval strategy was indicated by strategy probe reports and confirmed by an accurate solution and RT slower than 200 ms and slower than either 2,500 ms (older adults) or 1,000 ms (younger adults). We used the lower RT boundary to account for possible guessing behavior, as choice RT tasks cannot generally be responded to in less than 200 ms (e.g., Wilding & Sharpe, 2004). We used the upper RT boundaries to ensure that participants were not reporting retrieval use on trials for which they actually scanned. Most older adults take longer than 2,500 ms to scan the lookup table, and most younger adults take longer than 1,000 ms to scan the lookup table (Touron & Hertzog, 2004a, 2004b).

In Phase 2, all participants were shown self-paced instructions on recognition memory probes and then received 6 blocks of recognition memory probes for the Phase 1 stimulus set. Recognition memory trials were the same as standard NP trials, except that the lookup table was absent. Following each memory probe, participants reported their level of confidence that their preceding answer was correct by pressing a key labeled “0%” through “100%” in increments of 10. If participants answered the recognition memory probe incorrectly, the confidence judgment was followed by the word ERROR presented centrally on the following screen for 1 s, followed by the next trial. We did not use recognition memory probes in Phase 1 because they tend to increase retrieval use by older adults (Rogers & Gilbert, 1997; Touron & Hertzog, 2004b), which would reduce our opportunity to observe instructional effects.

Throughout the task, each block was followed by the opportunity to take a short break, during which the NP task program provided participants feedback on their mean RT and accuracy. In Phase 1, the program also presented participants with their average percentage of retrieval reports, and let them know whether or not a bonus point was earned (for participants in the incentives condition only) for the preceding block. After every 10 blocks, the program gave the participants a mandatory 1-min break. At the breaks following Blocks 10 and 20, the program gave participants in the incentives condition a reminder that it would become more difficult to gain points and to continue to strive for 100% accurate retrieval.

Following the NP task, participants completed a pen-and-paper measure that assessed their recall memory for the NP as well as their stimulus-specific and overall memory confidence. The cued recall test included judgments of learning (JOLs) to evaluate memory confidence and to ascertain whether individuals could discriminate items they had learned from items they had not yet learned (Touron & Hertzog, 2004b). The JOLs cued the participants with one word from a pair and asked them to rate their confidence that they could retrieve the matched pair on a later recall test (see Touron & Hertzog for a more complete description of this task).

We also had the experimenter give a mental model questionnaire (MMQ) to assess retention of the mental model provided by the initial instruction screens (Hertzog & Touron, 2006). The MMQ evaluates the degree to which participants believed that scanning or retrieval is the best strategy for the task, given the point in training (i.e., the beginning or end of the task) and participant goal (i.e., speed or accuracy). We considered MMQ responses that compared the relative values of scanning and retrieval for accurate versus speeded performance early and late in training were considered to be the most relevant to the current study. For these ratings, we presented scanning and retrieval values on a continuum, using a visual analog rating scale. Individuals placed a mark on the line indicating relative emphasis; the distance from the left endpoint was scaled 0 to 100. Ratings up to 50 indicate level of scanning value, ratings of 50 indicate equal value for scanning and retrieval, and ratings above 50 indicate level of retrieval value.

RESULTS

We performed a 2 (Age: young, old) × 3 (Condition: standard, instructions, incentives) × Block (30 in Phase 1, 6 in Phase 2) repeated measures analysis of variance on each dependent variable (Phase 1, RT, percentage correct for standard NP trials, and percentage retrieval strategy reporting for correct trials; Phase 2, percentage correct for recognition memory probe trials and confidence judgments). We also examined age and condition differences in post-task measures, including JOLs, recall accuracy, metacognitive ratings, and the MMQ.

Compliance Assessments

Providing monetary incentives for retrieval use in the incentives condition could have motivated participants to incorrectly label scanning responses as retrieval responses to gain points. We compared RT, RT standard deviation, and accuracy for reported scanning and retrieval trials. As would be expected with valid strategy reporting, scanning trials were slower, that is, $F(1, 114) = 235.12$, $MSE = 1{,}326{,}969$, $p < .01$, more variable, $F(1, 112) = 22.79$, $MSE = 2{,}324{,}571$, $p < .01$, and more accurate, $F(1, 114) = 11.05$, $MSE = 28.9$, $p < .01$, than retrieval trials. More important, strategy comparisons did not differ by condition, indicating that provision of monetary incentives did not lead to noncompliant strategy reporting.

Phase 1: Standard NP Task

Accuracy

Both age groups performed at a high level of accuracy (*M* = 93.5). Although accuracy increased somewhat with training, $F(29, 3{,}335) = 3.15$, $MSE = 33.6$, $p < .01$, we noted no interactions with the block variable, and we found no significant differences in accuracy between conditions or age groups.

Response times

Older adults responded more slowly than younger adults, $F(29, 3{,}335) = 4.33$, $MSE = 211{,}895$, $p < .01$ (see Figure 1). Improvements in RT occurred as participants learned the task, $F(29, 3{,}335) = 250.20$, $MSE = 211{,}895$, $p < .01$. Younger adults improved more rapidly than did older adults, leading to a significant Age × Block interaction, $F(29, 3{,}335) = 4.33$, $MSE = 211{,}895$, $p < .01$. We found no significant effects of condition or interactions with the condition variable for RT.

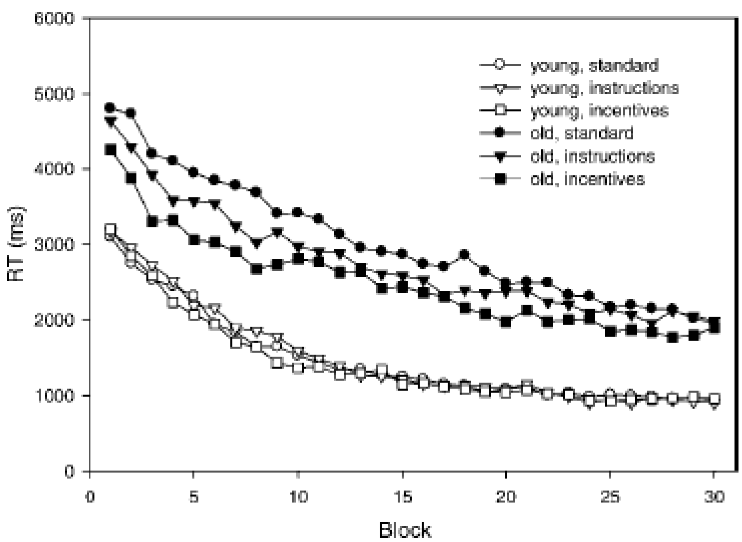

Figure 1. Mean response time (RT) by age, condition, and block.

Retrieval strategy use

Younger adults reported retrieval use on correct trials more often than did older adults, $F(1, 115) = 28.49$, $MSE = 13{,}976.4$, $p < .01$ (see Figure 2). Although retrieval use did not differ by condition ($p = .21$), the interaction between age and condition on retrieval strategy use approached significance, $F(2, 115) = 2.40$, $MSE = 13{,}976.4$, $p < .096$. Although this trend in isolation should obviously be weighed with caution, focused comparisons were consistent with the pattern that older adults in the incentives condition used retrieval more overall compared with older adults in the instructions condition, $p < .05$, and standard condition, $p < .03$. Focused comparisons of the young adult data did not indicate condition differences (*p*'s $> .76$).

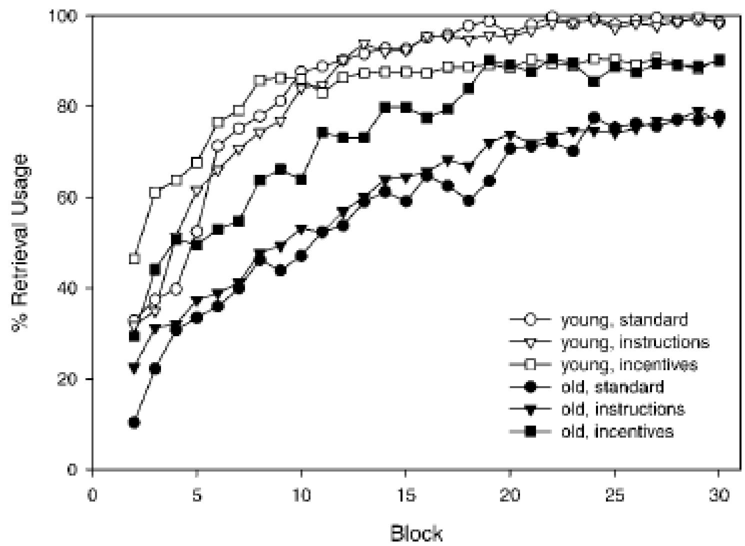

Figure 2. Mean percentage retrieval strategy use by age, condition, and block.

More critical to our interpretation are changes in retrieval use over block. Retrieval use increased with training, $F(28, 3{,}220) = 133.68$, $MSE = 252.8$, $p < .01$. Increases in retrieval use were more rapid for younger adults than for older adults, that is, $F(28, 3{,}220) = 4.05$, $MSE = 252.8$, $p < .01$, and varied by condition, $F(56, 3{,}220) = 1.86$, $MSE = 252.8$, $p < .01$). The Age × Condition × Block interaction was significant, $F(56, 3{,}220) = 4.05$, $MSE = 1.39$, $p < .03$, indicating that monetary incentives led to greater increases in retrieval use for older but not younger adults.

Even though retrieval use by young adults in the incentives condition appears to be higher early in training but lower late in training, a further analysis of this pattern, which separately examined early (Blocks 1–10) and late (Blocks 21–30) training, did not demonstrate reliable condition differences in the young adult sample (p's >.2).

In the final block of training, younger adults used retrieval more than did older adults, $F(1, 115) = 9.87$, $MSE = 570$, $p < .01$, and the Age × Condition interaction was significant, $F(2, 115) = 3.37$, $MSE = 570$, $p < .04$. Focused comparisons demonstrated that final retrieval use by older adults in the incentives condition was not statistically different from young adult retrieval in each condition (p's >.3). To account for possible ceiling effects, we also performed this comparison with an arcsine transformation on proportion retrieval use, and differences remained nonsignificant (p's >.1).

Phase 2: Recognition Memory Task

Accuracy

Younger adults responded more accurately to the recognition memory probes (M = 96.4) than did older adults (M = 87.1), that is, $F(1, 116) = 28.24$, $MSE = 564.7$, p <.01. The main effect of block was not significant (p =.08), but we did find a Block × Age interaction, $F(5, 580) = 6.32$, $MSE = 21.9$, p <.01. This interaction was driven by an increase in older adults' accuracy ($M_{\text{block 1}}$ = 84.2, $M_{\text{block 6}}$ = 88.9), compared with relative stability by young adults ($M_{\text{block 1}}$ = 97.3, $M_{\text{block 6}}$ = 96.0). There were no significant effects of condition on recognition memory (p's >.05).

A comparison of percentage of trials with reported retrieval use at the end of Phase 1 with level of recognition memory performance during Phase 2 suggests a retrieval reluctance by older adults in the standard (M_{ret} = 78.8, M_{mem} = 84.6) and instructions (M_{ret} = 77.3, M_{mem} = 88.4) conditions, but not by older adults in the incentives condition (M_{ret} = 92.5, M_{mem} = 88.1). Although percentage retrieval on correct trials and percentage correct recognitions are not completely commensurate, reversal of the typical difference between retrieval use and memory performance in the incentives condition indicates that incentives mitigate against unwarranted retrieval reluctance.

Confidence Judgments

As we expected (Touron & Hertzog, 2004b), memory confidence levels were high for both young adults and older adults (M = 94.8). We noted no main effects or interactions for the age, condition, or block variables (all p's >.05).

Post-Test Survey Measures

Global confidence, JOLs, and recall accuracy

Confidence and recall data are presented in Table 1. Younger adults reported higher memory confidence than older adults in their global ratings and JOLs, and they were indeed more accurate in the recall test. We noted no effects of condition, indicating that instructions and incentives influenced only strategy performance rather than memory confidence or memory performance.

To compare the relative accuracy of JOLs, we computed gamma correlations between recall and JOL ratings. Correlations were relatively high (M = 0.77, SE = 0.12) and did not differ by age (p =.8), indicating good discrimination of levels of acquired item knowledge for both younger and older adults. We observed no reliable condition differences in gammas (p =.5), indicating that instructions and incentives also did not influence the relative accuracy of JOLs.

To examine the relationship between task performance and these metacognitive judgments, we compared Pearson correlations between post-test measures and retrieval usage, aggregating data by condition (see Table 2). Replicating previous findings (Touron & Hertzog, 2004b), our findings showed that older adults' retrieval strategy choice was strongly related to various indices of task confidence in each condition.

Table 2. Correlations Between Metacognitive and Memory Performance Measures and End Retrieval Usage for Young and Older Adults

Measure	Young	Old
Global confidence	0.09	0.40*
Estimated memorization	0.04	0.51*
JOL	0.06	0.58*
Recall accuracy	0.04	0.46*
Recognition accuracy	0.12	0.28*
Recognition confidence	0.16	0.49*

Notes: End retrieval usage is percentage retrieval reporting for the last block of Phase 1; Global confidence rating and Estimated memorization are out of 100%; JOL = average post-task judgment of learning; Recall accuracy is post-task. Recognition accuracy and confidence are from Phase 2 testing.

*$p < .05$.

MMQ

We evaluated MMQ ratings to determine whether there were age and instruction effects on mental models for the benefits of each strategy for speed and accuracy early and late in practice. The mean ratings are reported in Table 3. For an accuracy-focused goal early in the task, participants rated the scanning strategy as more valuable than the retrieval strategy, a pattern more pronounced for young than for older adults. Speed instructions led to less scanning value in relative ratings than did standard instructions, and incentives led to even less scanning value in relative ratings. For an accuracy-focused goal late in the task and for speed-focused goals both early and late in the task, participants generally rated the retrieval strategy as more valuable than the scanning strategy, a pattern again more pronounced for young than for older adults, with no effect of condition. The MMQ data indicate that young adults retain a somewhat more accurate mental model of the NP task, as scanning is most valuable to ensure accuracy in early task performance but retrieval is always more efficient and is equally accurate late in training.

Table 3. MMQ Question Means (and Standard Errors) by Age and Condition

Questions	Young			Old		
	Std	Inst	Incent	Std	Inst	Incent
Accuracy, beginning[a,b]	19.52 (4.29)	26.21 (4.72)	34.48 (7.66)	27.68 (5.91)	38.25 (7.49)	49.18 (6.50)
Speed, beginning[a]	73.12 (4.24)	66.33 (6.39)	60.17 (7.88)	48.41 (5.56)	57.90 (5.94)	60.10 (5.79)
Accuracy, end[a]	63.24 (4.98)	63.00 (6.60)	61.78 (6.71)	52.14 (6.97)	41.05 (7.51)	60.55 (5.60)
Speed, end[a]	91.60 (2.34)	78.33 (6.02)	84.70 (5.28)	71.27 (5.40)	77.30 (6.03)	71.95 (6.75)

Notes: Conditions: Std = Standard, Inst = Instructions, Incent = Incentives. Question labels refer to items on the mental model questionnaire (MMQ), for which participants rated how often they should use the scanning strategy compared with the retrieval strategy in order to be (9) accurate at the beginning of the task, (10) fast at the beginning of the task, (11) accurate at the end of the task, and (12) fast at the end of the task. Ratings up to 50 indicate level of scanning value, ratings of 50 indicate equal value for scanning and retrieval, and ratings above 50 indicate level of retrieval value.

[a]Age significance is $p < .05$; [b]condition significance is $p < .05$; Age × Condition interactions were all nonsignificant.

The most critical aspect of the mental model with respect to task performance was the extent to which a participant values the retrieval strategy for accurate responding late in the task. This MMQ response correlated with global memory confidence (r =.22, p =.01), JOLs (r =.18, p =.04), and retrieval usage (r =.19, p =.04), but not significantly to actual recall or recognition memory ability (p's >.1).

DISCUSSION

The present study demonstrates that older adults' reluctance to shift to the memory retrieval strategy is ameliorated to a great extent when they are provided with modest monetary incentives, but not with instructions to emphasize speed alone. This finding supports the contention that age differences in skill acquisition can be influenced by strategic behavior and are under volitional control. Strategy selection and task performance correlated with differences in global and item-level memory confidence, as previously reported by Touron & Hertzog (2004a, 2004b), as well as to fundamental participant goals that comprise the mental task model.

The fact that monetary incentives were required to elevate older adults' retrieval use suggests that the tendency for conservatism in the NP task could reflect a fundamental difference between younger and older adults in the extent to which accuracy and speed of response are intrinsically valued. This conjecture is consistent with other evidence that older adults have conservative speed-accuracy response criteria that are not easily modified (e.g., Hertzog et al., 1993). Older adults apparently believe that responding accurately is intrinsically more valuable than responding efficiently. If so, then the fact that both scanning and retrieval are paths to a correct response, with retrieval use early in practice being a more risky path, may lead many older adults to maintain the slow but accurate scanning approach. There are individual differences within the older group in this tendency, and older adults who report low confidence in their ability to use the retrieval strategy are more likely to avoid it. The effect of incentives, apparently, overrides this tendency to a greater extent than manipulations we have already evaluated (inserting recognition memory probes, changing relative affordances of task demands for the two strategies). Considering the profound improvements obtained currently for older adults' strategic behavior and cognitive task performance, future research might implement such bonus provisions to examine the flexibility of age differences in other complex cognitive domains.

As discussed more extensively elsewhere (Touron & Hertzog, 2004b), age differences in retrieval usage early in NP task practice undoubtedly reflect in part age differences in rates of incidental learning of new associations, which is known to be impaired by aging (Kausler, 1994; Naveh-Benjamin, 2000). Recently, Naveh-Benjamin, Brav, & Levy (in press) showed that instructions to use mediators at encoding and retrieval repaired the age-related associative deficit identified by Naveh-Benjamin and colleagues. It is possible that monetary incentives in our study caused older individuals to shift to more effortful memorization strategies during learning and at test, thereby overcoming an associative deficit that contributes to rates of retrieval shift. However, the retrieval shift we have studied in the NP task is not necessarily mediated by intentional memorization. In any case, retrieval usage is a self-enhancing behavior, because retrieval strategy usage provides memory practice that fosters increased memory ability (see Allen, Mahler, & Estes, 1969). Thus, older adults' retrieval reluctance may be even more profoundly maladaptive, serving to not only to reduce current efficiency but to constrain the rate of incidental learning.

It is important to remember, however, that associative learning deficits are not an adequate explanation of older adults' retrieval reluctance in the NP task. Older adults show delayed shift even when the NP are learned to criterion prior to the initiation of NP task trials (Touron & Hertzog, 2004b). Moreover, despite finding that monetary incentives increase older adult's retrieval strategy usage, we did not find that increased retrieval practice translated into improved memory performance. Nor did it increase trial-level memory confidence. Thus, the enhancement of retrieval use created by incentives is not sufficient to increase underlying rates of NP item learning. Nevertheless, providing incentives boosted older adults' retrieval use without impairing their NP task accuracy, suggesting that an associative deficit per se was not constraining older adults' retrieval reluctance.

Although the provision of incentives clearly increased retrieval reliance by older adults, young adult data did not show the same effect. Although young adults in the incentives condition used retrieval frequently in early training, they were not more likely to use retrieval overall, even appearing to reach a retrieval plateau that was lower than the ceiling performance of young adults in the standard and instructions conditions (although this effect was not statistically reliable). Given that young adults in the incentives condition were already consistently above criterion levels, the age differences in retrieval patterns present the possibility that the monetary incentive system provided both retrieval motivation (if needed, as for older adults) as well as an explicit criterion level of retrieval performance. Although the incentives criteria were not explicitly provided, participants given incentives may have recalibrated their maximal performance goals on the basis of the accumulation of bonus points. Retrieval use by older adults in the incentives condition closely followed the levels required to gain points, suggesting that future research using more stringent criteria might demonstrate even faster adoption of the retrieval strategy.

In sum, the present study adds to growing evidence that older adults' strategy shift is influenced both by associative learning deficits and by a volitional reluctance to switch to the memory retrieval strategy. This reluctance characterizes some, but not all older adults, with older adults who have low confidence in their ability to use memory retrieval or who have mental models valuing the benefits of scanning for accuracy least likely to shift to retrieval. This retrieval reluctance is resistant to speed-emphasis instructions, but it can be overridden by incentives to respond quickly.

ACKNOWLEDGMENTS

This research was supported by National Institute on Aging Grant NIA R01 AG024485 awarded to Christopher Hertzog and Dayna Touron. This research fulfilled part of a Master's thesis requirement for Elizabeth Swaim, who is now pursuing a doctorate at North Carolina State University.

We extend special thanks to the research team at Appalachian State University, particularly Jarrod Hines and Zach Speagle, for their assistance with subject recruitment and data collection, and to Todd McElroy and Doug Waring for comments on a previous version of this article.

REFERENCES

Ackerman, P. L., Woltz, D. J. (1994). Determinants of learning and performance in an associative memory/substitution task: Task constraints, individual differences, volition, and motivation. Journal of Educational Psychology, 86,487-515.

Allen, G. A., Mahler, W. A., Estes, W. K. (1969). Effects of recall tests on long-term retention of paired associates. Journal of Verbal Learning and Verbal Behavior, 8,463-470.

Birkhill, W. R., Shaie, K. W. (1975). The effect of differential reinforcement of cautiousness in intellectual performance among the elderly. Gerontology, 30,578-583.

Bosman, E. A., Charness, N. (1996). Age differences in skilled performance and skill acquisition. In T. Hess & F. Blanchard-Fields (Eds.), Perspectives on cognitive change in adulthood and aging (pp. 428–453). New York: McGraw-Hill.

Brebion, G. (2001). Language processing, slowing, and speed/accuracy trade-off in the elderly. Experimental Aging Research, 27,137-150.

Desrocher, M., Smith, M. L. ((2005),). Intrapersonal and extrapersonal space: Performance of older adults on ecologically valid orientation tasks. Experimental Aging Research, 31,205-216.

Dunlosky, J., Hertzog, C. (1998). Aging and deficits in associative memory: What is the role of strategy production? Psychology and Aging, 13,597-607.

Hertzog, C., Hultsch, D. F. (2000). Metacognition in adulthood and old age. In F. I. M. Craik & T. A. Salthouse (Eds.), The handbook of aging and cognition (2nd ed., pp. 417–466). Mahwah, NJ: Erlbaum.

Hertzog, C., Touron, D. R. (2006). Aging and individual differences in algorithm to retrieval shift with practice. Poster presented at the 2006 Cognitive Aging Conference, Atlanta, GA.

Hertzog, C., Vernon, M. C., Rympa, B. (1993). Age differences in mental rotation task performance: The influence of speed/accuracy tradeoffs. Journal of Gerontology: Psychological Sciences, 48B,P150-P156.

Honeywell, J. A., Dickinson, A. M., Poling, A. (1997). Individual performance as a function of individual and group pay contingencies. The Psychological Record, 47,261-268.

Hoyer, W. J., Cerella, J., Onyper, S. V. (2004). Item learning in cognitive skill training: Effects of item difficulty. Memory & Cognition, 31,1260-1270.

Kanfer, R., Ackerman, P. L. (1989). Motivation and cognitive abilities: An integrative/aptitude-treatment interaction approach to skill acquisition. Journal of Applied Psychology, 74,657-690.

Kausler, D. H. (1994). Learning and memory in normal aging. San Diego, CA: Academic Press.

Lineweaver, T. T., Hertzog, C. (1998). Adults' efficacy and control beliefs regarding memory and aging: Separating general from personal beliefs. Aging, Neuropsychology, & Cognition, 5,264-296.

Logan, G. D. (1988). Toward an instance theory of automatization. Psychological Review, 95,492-527.

McDonald-Miszcak, L., Hertzog, C., Hultsch, D. F. (1995). Stability and accuracy of metamemory in adulthood and aging: A longitudinal analysis. Psychology & Aging, 10,553-564.

Naveh-Benjamin, M. (2000). Adult age differences in memory performance: Tests of an associative deficit hypothesis. Journal of Experimental Psychology: Learning, Memory, and Cognition, 26,1170-1187.

Naveh-Benjamin, M., Brav, T. K., Levy, O., in press The associative memory deficit of older adults: The role of efficient strategy utilization. Psychology and Aging.

Ratcliff, R., Spieler, D., McKoon, G. (2000). Explicitly modeling the effects of aging on response time. Psychonomic Bulletin & Review, 7,1-25.

Rickard, T. C. (1997). Bending the power law: A CMPL theory of strategy shifts and the automatization of cognitive skills. Journal of Experimental Psychology: General, 126,288-310.

Rickard, T. C. (2004). Strategy execution in cognitive skill learning: An item-level test of candidate models. Journal of Experimental Psychology: Learning, Memory, and Cognition, 30,65-82.

Rogers, W. A., Gilbert, D. K. (1997). Do performance strategies mediate age-related differences in associative learning? Psychology and Aging, 12,620-633.

Rogers, W. A., Hertzog, C., Fisk, A. D. (2000). An individual differences analysis of ability and strategy influences: Age-related differences in associative learning. Journal of Experimental Psychology: Learning, Memory, and Cognition, 26,359-394.

Salthouse, T. A. (1979). Adult age and the speed–accuracy trade-off. Ergonomics, 22,811-821.

Schunn, C. D., Reder, L. M. (2001). Another source of individual differences: Strategy adaptivity to changing rates of success. Journal of Experimental Psychology: General, 130,59-76.

Shah, J., Higgins, T., Friedman, R. S. (1998). Performance incentives and means: How regulatory focus influences goal attainment. Journal of Personality and Social Psychology, 74,285-293.

Shiffrin, R. M., Schneider, W. (1977). Controlled and automatic human information processing: II. Perceptual learning, automatic attending, and a general theory. Psychological Review, 84,127-190.

Shum, D. H., O'Gorman, J. G., Alpar, A. (2004). Effects of incentive and preparation time on performance and classification accuracy of standard and malingering-specific memory tasks. Archives of Clinical Neuropsychology, 19,817-823.

Siegler, R. S., Lemaire, P. (1997). Older and younger adults' strategy choices in multiplication: Testing predictions of ASCM using the choice/no-choice method. Journal of Experimental Psychology: General, 126,71-92.

Strayer, D. L., Kramer, A. F. (1994). Aging and skill acquisition: Learning-performance distinctions. Psychology and Aging, 9,589-605.

Thapar, A., Ratcliff, R., McKoon, G. (2003). A diffusion model analysis of the effects of aging on letter discrimination. Psychology and Aging, 18,415-429.

Touron, D. R. (2006). Are item-level strategy shifts abrupt and collective? Age differences in cognitive skill acquisition. Psychonomic Bulletin & Review, 13,781-786.

Touron, D. R., Hertzog, C. (2004a). Strategy shift affordance and strategy choice in young and older adults. Memory & Cognition, 32,298-310.

Touron, D. R., Hertzog, C. (2004b). Distinguishing age differences in knowledge, strategy use, and confidence during strategic skill acquisition. Psychology and Aging, 19,452-466.

Touron, D. R., Hertzog, C. (2005). Age differences in the influence of instructions on associative learning. Unpublished manuscript.

Touron, D. R., Hoyer, W. J., Cerella, J. (2001). Cognitive skill acquisition and transfer in younger and older adults. Psychology and Aging, 16,555-563.

Touron, D. R., Hoyer, W. J., Cerella, J. (2004). Cognitive skill learning: Age-related differences in strategy shifts and speed of component operations. Psychology and Aging, 19,565-580.

Wilding, E. L., Sharpe, H. (2004). The influence of response-time demands on electrophysiological correlates of successful episodic retrieval. Cognitive Brain Research, 18,185-195.

Zachary, R. (1986). Shipley Institute of Living Scale Revised Manual. Los Angeles: Western Psychological Services.