Psychon Bull Rev (2012) 19:743–749
DOI 10.3758/s13423-012-0266-2

BRIEF REPORT

Consequences of restudy choices in younger and older learners

Jonathan G. Tullis · Aaron S. Benjamin

Published online: 15 May 2012

Abstract Allowing young learners to exert metacognitive control over learning often improves memory performance; however, little research has examined the consequences of giving older adults control over learning. In this study, younger and older adults studied word pairs before choosing half of the word pairs for restudy. Learners either restudied the items they chose (in the *honor* condition) or the items they did not choose (the *dishonor* condition; Kornell & Metcalfe, Journal of Experimental Psychology: Learning, Memory, and Cognition 32:609–622, 2006). Older and younger learners chose the same types of items for restudy, but the effectiveness of these choices differed greatly by age. For young learners, memory was superior in the honor condition, but older learners actually revealed numerically higher performance in the dishonor condition. This reveals a dramatic failure of metacognitive control, in the absence of any obvious monitoring deficit, in older adults. Implications for models of self-regulated learning are discussed.

Keywords Metacognition · Aging · Metacognitive control · Item selection

Students often decide what to study, when to study, how to study, and how much to study, especially when studying outside the direct supervision of an instructor. The accuracy of their metacognitive monitoring influences study choices and, consequently, how well information is learned and retained (Theide, Anderson, & Therriault, 2003; Tullis & Benjamin, 2011). If learners' metacognitive accuracy is incomplete or flawed, they may make ineffective choices about how best to learn material. The effectiveness of learners' self-regulated study choices has important implications for educational and learning practices (Dunlosky & Theide, 1998; Finley, Tullis, & Benjamin, 2010). In this article, we explore the effectiveness of giving older learners control over their restudy choices.

J. G. Tullis (✉) · A. S. Benjamin
Department of Psychology, University of Illinois,
603 E. Daniel St.,
Champaign, IL 61820, USA
e-mail: jtullis2@illinois.edu

Effectiveness of self-regulation

Allowing learners to control their learning to improve memory has produced mixed results. Learners seem to make decisions about study activities that have effective immediate consequences for learning but fail to incorporate activities that benefit long-term learning at the expense of immediate learning (Nelson, Dunlosky, Graf, & Narens, 1994; Son, 2004; Son & Metcalfe, 2000; Tullis, Finley, & Benjamin, 2012). Learners succeed at effectively allocating study time across a set of heterogeneously difficult items (Tullis & Benjamin, 2011) and judiciously choosing which items they should restudy (Kornell & Metcalfe, 2006; Nelson et al., 1994) but do not always effectively distribute repetitions of items in time (Benjamin & Bird, 2006) and rarely utilize self-testing during learning to improve final memory performance (Karpicke, 2009).

While the effectiveness of younger learners' study choices has been evaluated, the effectiveness of self-regulated learning in older adults remains largely unexplored. There are reasons to suspect that older adults may have difficulty with self-regulating learning. Older learners often overestimate the amount that they will eventually recall (Connor, Dunlosky, & Hertzog, 1997), and they misjudge the effectiveness of encoding strategies (sometimes, even after considerable experience with them; Brigham & Pressley, 1988; cf. Tullis & Benjamin, in press). Inaccuracies in monitoring can lead to ineffective study choices. Furthermore, self-regulation may not be as beneficial for older adults, because they may not appropriately utilize the output of metacognitive monitoring to guide their subsequent learning choices (Dunlosky & Connor, 1997).

Research concerning older adults' effectiveness at regulating learning has been limited to the self-pacing domain. Older adults do not distribute study time in accordance with item difficulty to the same extent as younger learners (Miles & Stine-Morrow, 2004; Souchay & Isingrini, 2004), and this reduction in study time modulation may contribute to older adults' poorer memory performance on self-paced learning tasks (Dunlosky & Connor, 1997). In the present experiment, we extended the research into the effectiveness of older adults' metacognitive control by investigating the consequences of allowing older adults the opportunity to choose a subset of items for additional study.

The effectiveness of item selection

Effectively selecting items for restudy is a fundamental skill needed during self-regulated learning. Younger adults choose items for restudy effectively, even if not optimally. Atkinson (1972) showed that learners chose to restudy German–English word pairs that they judged to be the most poorly mastered. This strategy was more effective than a random selection process, but less effective than a computer algorithm that factored in the items' normative difficulty and the learners' current knowledge states. Similarly, Nelson et al. (1994) showed that people who restudied self-selected items exhibited better memory than people who restudied either the normatively most difficult items or the items judged to be the most well learned. Dunlosky and Hertzog (1997) replicated portions of Nelson et al.'s experiment with older adults and showed that they, like younger adults, selected for restudy the items judged to be the most poorly learned. Although older learners' performance increased across multiple restudy–test blocks, it is not clear whether control over which items to restudy played a role in the increase over trials. A procedure introduced by Kornell and Metcalfe (2006)—the *honor/dishonor* procedure—allows such an evaluation. We will return to this point shortly.

Why might restudying the most poorly learned items not be as beneficial a strategy for older adults? For older adults, even the easy or well-learned items may not be particularly well learned after one study session, given the significant deficits they exhibit, when compared with younger learners, in self-initiated recall tasks (Craik & McDowd, 1987). Older adults may benefit most from restudying somewhat easier items because easy items can transition from an unlearned state to a learned state with a single additional study session, while difficult items cannot. The easy items may exist in older learners' *region of proximal learning* (Metcalfe, 2002), while the difficult items may be far out of reach for older adults. Additionally, older adults are often overconfident in their predictions of how many items from a list they will recall (Connor, Dunlosky, & Hertzog, 1997). Because of this overconfidence, older learners may not realize how much they can still benefit from restudying the easier items and how little they will benefit from restudying the difficult items. Older adults may not understand their own age-related memory limitations and, therefore, may allocate resources ineffectively to the difficult items instead of the easy items (Stine-Morrow, Loveless, & Soederberg, 1996). However, older learners can learn about their limitations through task experience (McGillivray & Castel, 2011).

Honoring or dishonoring a learner's choices and comparing subsequent memory performance is one means of assessing the effectiveness of a learner's choices. Kornell and Metcalfe (2006) showed that honoring the learner's restudy choices (by re-presenting the half of the items that a learner selected for restudy) produced greater memory performance for both general knowledge questions and word pairs than did dishonoring those choices (by re-presenting the half of the items that a learner did not select for restudy).

In the present experiment, we used the same procedure as that in Kornell and Metcalfe (2006) to investigate the effectiveness of older adults' restudy choices. Younger and older adults studied a list of heterogeneously difficult word pairs, provided cue-only judgments of learning (JOLs), chose half of the word pairs to restudy, restudied half of the word pairs, and took a cued recall test on all of the word pairs. Item-by-item JOLs were collected to enable us to characterize each subject's monitoring accuracy and subjective restudy selection strategy. Additionally, to determine the effectiveness of learners' item selection choices, cued recall performance was compared between learners whose restudy choices were honored and learners whose choices were dishonored.

Method

Subjects

Thirty-six introductory-level psychology students from the University of Illinois at Urbana-Champaign participated in partial fulfillment of class requirements. Additionally, 37 community-dwelling older adults (age range = 60–80 years; median age = 66) participated in exchange for nominal compensation. All older adults were high functioning, as indicated by high performance on both the Mini-Mental State Exam (M = 28.9) and the Shipley vocabulary scale (M = 35.9). (Their vocabulary score is numerically higher than that for younger subjects who have been in our laboratory for similar experiments.)

Materials

The items utilized in this experiment consisted of 30 concrete and 30 abstract 4- to 8-letter nouns collected from the Medical Research Council Psycholinguistic Database (Coltheart, 1981). The concrete nouns varied in concreteness on their scale from 600 to 645 (M = 612.6), while the abstract nouns varied from 232 to 300 (M = 278.2). In order to manipulate objective item difficulty, abstract nouns were randomly paired with other abstract nouns and concrete nouns were randomly paired with other concrete nouns to form 15 concrete–concrete and 15 abstract–abstract cue–target word pairs for each subject. Abstract–abstract word pairs are usually more difficult to recall than concrete–concrete word pairs (Paivio, Smythe, & Yuille, 1968), and learners' JOLs are usually sensitive to concreteness (Hertzog, Dunlosky, Robinson, & Kidder, 2003). Presentation of the stimuli, as well as response recording, was done using the Psychophysics Toolbox extensions (Brainard, 1997) in MATLAB on PCs.

Design

The experiment utilized a 2 (honor/dishonor) × 2 (younger/older) × 2 (concrete/abstract words) mixed quasi-experimental design. The age and honor conditions were between-subjects variables, and the concreteness variable was manipulated within subjects. Younger subjects were evenly split between the honor conditions, while 18 older adults were assigned to the honor condition and 19 were assigned to the dishonor condition. One older adult was excluded from the honor condition for writing down word pairs during study.

Procedure

Subjects were alternatively assigned to the dishonor and honor conditions on the basis of the order of arrival at the lab, and they completed the experiment in individual rooms. Detailed directions about the task, including a thorough explanation of the final cued recall task they would be given, were presented on the computer. Subjects read an explanation of interactive imagery, were told that using this strategy often helps people remember word pairs, and were given an example of how to use the strategy. Interactive imagery instructions were given in order to make the strategies utilized between age groups somewhat comparable (Naveh-Benjamin, Brav, & Levy, 2007).

Word pairs were presented on the center of a computer monitor in black Arial 60-point font in a random order during the initial study phase. Word pairs were presented for 10 s each for older subjects; for younger subjects, word pairs were presented for only 5 s each. Differential study times were given to the age groups in order to try to equate overall memory performance between the age groups and to prevent any scaling issues from impeding comparison of the age groups. Between each word pair presentation, a blank screen appeared for 0.5 s. After studying all the word pairs, subjects were presented with each cue individually and were asked to predict the recall of the target on a 1–4 scale. On the scale, 1 indicated *I am sure that I will NOT remember the right-side word*, 2 indicated *I think I will NOT remember the right-side word*, 3 indicated *I think I WILL remember the right-side word*, and 4 indicated *I am sure that I WILL remember the right-side word*. The rating scale was displayed at the bottom of the screen during all predictions, and subjects were allowed as much time as they needed to make their judgments (Benjamin, 2005). After subjects had made their prediction for a cue, the next cue was presented on the screen, and this continued until the subjects made a prediction for every studied cue.

After they finished the rating phase, subjects were told to select 15 out of the 30 items that they would like to restudy. The entire set of cues was presented in random order on the screen in a 6 × 5 array simultaneously, as in Thiede and Dunlosky (1999). Each cue was labeled with a number (1–30), and subjects selected items that they wanted to restudy by typing the cue's corresponding number. The cues disappeared from the array when they were selected. The computer dynamically updated how many items had been selected and how many more items could be selected throughout the selection phase. After 15 cues had been selected, subjects began the restudy phase. Subjects in the honor condition restudied the 15 word pairs they had selected for study, while subjects in the dishonor condition restudied the 15 words pairs they had not selected for restudy. During the restudy phase, word pairs were re-presented exactly as during the first study phase, but in a new random order. Finally, subjects engaged in the cued recall task, where they were given each cue and asked to type in the appropriate target item.

Results

The results of all inferential statistics reported below and throughout this article are reliable at the $\alpha < .05$ level, using two-tailed tests, unless otherwise noted, and effect sizes are reported as Cohen's d. We will first present the item selection results from young and older subjects, followed by the final cued recall performance of both groups.

Metacognitive judgments and item selection

In order to assess metacognitive accuracy, we first report the JOLs for the concrete and abstract words and then the results from the item selection. Young subjects' JOLs were higher for concrete word pairs (M = 2.86) than for abstract word pairs (M = 2.40), $t(35)$ = 3.90, d = 0.66. Similarly, older subjects' JOLs were higher for concrete word pairs (M =

3.19) than for abstract word pairs (M = 2.31), $t(35)$ = 8.46, d = 1.43. The fact that concrete word pairs elicited higher JOLs than did abstract pairs indicates somewhat accurate metacognitive predictions, as borne out by higher overall levels of recall for concrete pairs (see below). The absolute accuracy of the metacognitive predictions cannot be assessed, because JOLs were solicited on a different scale than our criterion measure (cued recall). Instead, we present a relative measure of accuracy: the gamma correlations between predictions and performance (cf. Benjamin & Diaz, 2008). The gamma correlations between JOLs and final memory performance for the words studied only once were high and did not differ between young and older learners (G = .76 and .85, respectively), $t(54)$ = 0.85, d = 0.16.

Young learners chose to restudy more abstract word pairs, as indicated by a negative gamma correlation between restudy choice and a categorical indicator of concreteness (G = −.40), $t(34)$ = 2.52. Young learners recalled more concrete word pairs than abstract word pairs, $t(36)$ = 3.58, d = 0.60, and this pattern was consistent across both honor and dishonor conditions. The JOLs for selected and nonselected word pairs are displayed in Fig. 1. The word pairs selected for restudy by the young subjects were accorded lower JOLs (M = 2.14) than were those not selected for restudy (M = 3.12), $t(35)$ = 7.50, d = 1.22. The gamma correlation between JOL and restudy choice was significantly less than zero (G = −.66), $t(34)$ = 5.12, confirming that young subjects chose to restudy items with lower JOLs.

Older subjects showed the same patterns in metacognitive monitoring and item selection as younger subjects. Older subjects were more likely to choose abstract word pairs for restudy than to choose concrete pairs (G = −.48), $t(34)$ = 3.18. Like younger learners, regardless of honor condition, older learners recalled more concrete word pairs than abstract word pairs, $t(35)$ = 11.52, d = 1.95. The items selected for restudy by the older adults were accorded lower JOLs (M = 2.24) than were those not selected for restudy (M = 3.21), $t(35)$ = 7.10, d = 1.23. Corroborating the idea that older subjects chose the items with the lowest JOLs, the gamma correlation between JOLs and restudy choice was significantly less than zero (G = − .62), $t(33)$ = 4.56, and very similar in magnitude to that of younger adults. Both older and younger learners' gamma correlations between study choices and JOLs were smaller here than in prior research (i.e., Dunlosky & Hertzog, 1997). In our procedure, learners made JOLs immediately after studying a complete word pair, while choosing items to restudy occurred much later, when only the cues were present. The different cues available to learners at these different times may depress the magnitude of the correlation between JOLs and study choices, when compared with prior research.

Cued recall performance

Cued recall performance collapsed across whether items were restudied or not for each condition and age group is displayed in Fig. 2. A 2 × 2 between-subjects ANOVA revealed a significant interaction between age group and condition [honor vs. dishonor, $F(1, 67)$ = 5.42, d = 1.19], with no significant main effects. Post hoc t-tests revealed that cued recall performance was higher for younger subjects whose choices were honored (M = 0.67) than for younger subjects whose choices were dishonored (M = 0.48), $t(34)$ = 2.24, d = 0.40. This effect did not obtain in the older adult sample; cued recall performance was actually numerically lower for older subjects whose choices were honored (M = 0.47) than for older subjects whose choices were dishonored (M = 0.53), $t(33)$ = 0.86, p = .40, d = 0.17.

Discussion

Older subjects were similar to younger subjects in metacognitive monitoring, strategy selection, and strategy implementation; however, their pattern of memory performance shows dramatic differences. Both younger and older subjects chose to restudy the difficult items, as measured by subjects' subjective judgments (their JOLs) and objective measures (concreteness), which confirms previous findings (Dunlosky & Hertzog, 1997). The young subjects' memory performance benefited greatly from honoring learners'

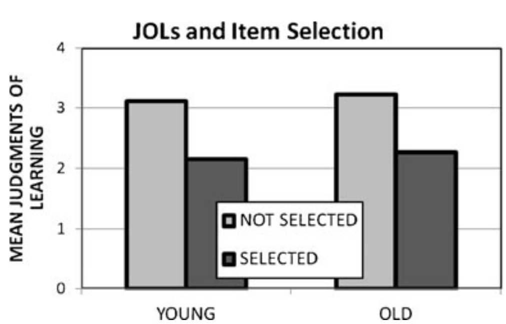

Fig. 1 Mean judgments of learning (JOLs) split by restudy selection and age group

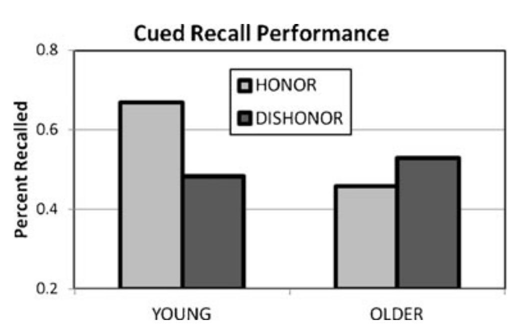

Fig. 2 Cued recall performance split by condition (honor vs. dishonor) and age group

selections; this result corroborates extant results (Kornell & Metcalfe, 2006; Nelson et al., 1994). However, honoring older learners' item selection choices did not boost memory performance.

In order to make optimal study choices, learners must weigh many different variables, including the current learning state of each item, the total available study time, and the potential improvement in learning from future study for each item. Models of self-regulated learning differ about the importance of potential mnemonic improvement from restudy. The discrepancy-reduction viewpoint suggests that learners base their study judgments solely on current states of learning and, therefore, posits no role for predictions of future mnemonic gain during restudy (Theide & Dunlosky, 1999). The region-of-proximal-learning viewpoint, however, suggests that learners utilize predictions of future mnemonic gains (which is a direct function of the current *rate* of learning) to make study choices (Metcalfe, 2002). In their model of optimal study time allocation, Son and Sethi (2006) argued that the most critical variable when effectively selecting items for restudy is the potential gain, as reflected in the interaction of the current level of learning and the shape of each item's learning curve. Another model suggests that the agenda of the learners, which is driven by their goals and task constraints, is the most important factor in determining study decisions (Ariel, Dunlosky, & Bailey, 2009). In this view, learners may select items that are outside of their region of proximal learning; however, it is not clear what agenda would drive older adults to select items for restudy that would impair their ultimate performance.

The actual mnemonic gains from restudying chosen and nonchosen items for each age group are displayed in Fig. 3. Gains reveal how much mnemonic benefit accrues from restudying a particular type of item (chosen/unchosen), relative to performance on that type of item when it was studied only once. The score is calculated across subjects by subtracting performance on a set of items by a group of subjects who studied the set only once from the performance by a group of

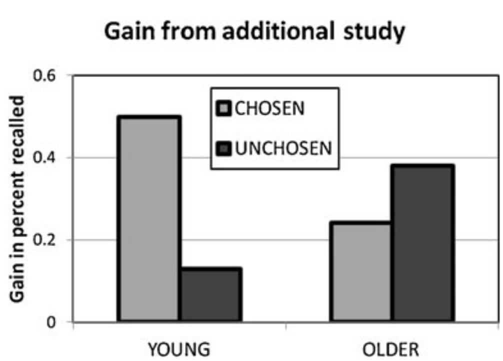

Fig. 3 Percentage gain in recall scores from additional study split by age group and type of item (selected for restudy or not selected for restudy). Gain = performance on twice-studied items − performance on once-studied items

subjects who studied that same set of items twice (i.e., percent gain on chosen items = performance on chosen items studied twice − performance on chosen items studied once). Computing a traditional inferential statistic for this measure is not possible, because gains must be computed from the overall mean of each group, giving us no measure of variability. Instead, we randomly permuted scores on chosen items to once-studied or twice-studied conditions within age group and honor conditions in order to evaluate whether the restudy condition interacted with age group. This particular permutation procedure preserved the main effects of the variables but asymptotically eliminated the interaction. We generated 1,000 distributions this way, calculated the group gains on the basis of these distributions, and assessed how extreme our obtained interaction statistic was on the basis of this empirically generated sampling distribution. This analysis revealed that the interaction between age and item type (chosen vs. unchosen) is reliable ($p < .005$). Follow-up tests using the same sampling distributions indicated that younger subjects benefited significantly from restudying the chosen items ($p = .005$), but older subjects showed no such effect; in fact, they benefited numerically more from restudying the unchosen items than from restudying the chosen items ($p = .12$).

Cognitive load required during item selection may determine whether learners can effectively select items to restudy. Young learners seem to choose items within their region of proximal learning when cognitive demands of selecting items are minimal (Theide & Dunlosky, 1999). As the cognitive demands of selecting items increases, younger learners select to restudy the most difficult items rather than the items just beyond their reach (Theide & Dunlosky, 1999). The ability of older learners to select items within their region of proximal learning for restudy has not been assessed in prior research. However, the ability to shift study decisions to easier materials during learning, which is the primary evidence favoring the region-of-proximal-learning framework for younger learners (Metcalfe, 2002), is significantly impaired in older adults (Stine-Morrow, Shake, Miles, & Noh, 2006). Older adults may fail to select items within their region of proximal learning during self-regulated learning because considering potential mnemonic gain may be beyond their limited resources.

Exactly how study decisions were made for each group is unclear. Both groups of learners may have based restudy choices on their current absolute level of learning, selecting the subjectively most difficult items for restudy. For younger learners, the worst-learned items may naturally lie in their regions of proximal learning, leading to a concordance between discrepancy-reduction and proximal-learning selection strategies. For older learners, these worst-learned items may lie far outside of their region of proximal learning. Their performance was impaired by restudying those selected items, because they selected items too difficult to learn in a single additional restudy opportunity and neglected easier items that could have benefited from additional restudy. For older learners, the region of proximal learning and discrepancy-reduction selection strategies highlighted different sets of material for restudy, and older learners' selections seemed to adhere more closely to the discrepancy-reduction strategy.

Alternatively, younger learners may have considered the potential mnemonic gain during restudy and may have chosen the items that provided them the biggest mnemonic boost (which happened to be the worst-learned items). This claim is, however, difficult to reconcile with research that suggests that even younger learners fail to understand how much can be gained from future study (Kornell & Bjork, 2008; Nelson & Leonesio, 1988). The inability of younger learners to predict future gains hints that both younger and older learners make restudy choices on the basis of the absolute level of learning rather than potential mnemonic benefits. If both older and younger learners use current, static levels of learning to make restudy choices, both may benefit from metacognitive training (Hertzog & Dunlosky, 2011) that focuses on utilizing potential benefits to inform restudy choices.

This study reveals a dramatic failure of older learners to improve memory through effective selection of items for restudy, a fundamental aspect of metacognitive control. Even though, in this study, older adults' metacognitive monitoring is as accurate as younger adults' and they choose the same types of items to study as younger adults, older adults do not benefit from having control over item selection. Effectively controlling learning is a complex process that requires knowledge of future gain from study. By not taking future gain into account during item selection, older adults inefficiently choose to restudy the difficult items even though they could gain more from restudying the easier items. Consequently, older adults do not benefit in the same way that younger adults do from having control over what items they restudy.

Author Note This research was funded in part by Grant R01 AG026263 from the National Institutes of Health.

References

Ariel, R., Dunlosky, J., & Bailey, H. (2009). Agenda-based regulation of study-time allocation: When agendas override item-based monitoring. *Journal of Experimental Psychology: General, 138*, 432–447.

Atkinson, R. C. (1972). Optimizing the learning of a second-language vocabulary. *Journal of Experimental Psychology*, *96*, 124–129.

Benjamin, A. S. (2005). Response speeding mediates the contribution of cue familiarity and target retrievability to metamnemonic judgments. *Psychonomic Bulletin & Review*, *12*, 874–879.

Benjamin, A. S., & Bird, R. D. (2006). Metacognitive control of the spacing of study repetitions. *Journal of Memory and Language*, *55*, 126–137.

Benjamin, A. S., & Diaz, M. (2008). Measurement of relative metamnemonic accuracy. In J. Dunlosky & R. A. Bjork (Eds.), *Handbook of memory and metamemory* (pp. 73–94). New York, NY: Psychology Press.

Brainard, D. H. (1997). The Psychophysics Toolbox. *Spatial Vision*, *10*, 433–436.

Brigham, M. C., & Pressley, M. (1988). Cognitive monitoring and strategy choice in younger and older adults. *Psychology & Aging*, *3*, 249–257.

Coltheart, M. (1981). The MRC psycholinguistic database. *Quarterly Journal of Experimental Psychology*, *33A*, 497–505.

Connor, L. T., Dunlosky, J., & Hertzog, C. (1997). Age-related differences in absolute but not relative metamnemonic accuracy. *Psychology and Aging*, *12*, 50–71.

Craik, F. I., & McDowd, J. M. (1987). Age differences in recall and recognition. *Journal of Experimental Psychology, Learning, Memory, and Cognition*, *13*, 474–479.

Dunlosky, J., & Connor, L. T. (1997). Age differences in the allocation of study time account for age differences in memory performance. *Memory & Cognition*, *25*, 691–700.

Dunlosky, J., & Hertzog, C. (1997). Older and younger adults use a functionally identical algorithm to select items for restudy during multitrial learning. *Journal of Gerontology: Psychological Sciences*, *52*, 178–186.

Dunlosky, J., & Thiede, K. W. (1998). What makes people study more? An evaluation of factors that affect people's self-paced study and yield "labor-and-gain" effects. *Acta Psychologica*, *98*, 37–56.

Finley, J. R., Tullis, J. G., & Benjamin, A. S. (2010). Metacognitive control of learning and remembering. In M. S. Khine & I. Saleh (Eds.), *New science of learning: Cognition, computers and collaboration in education* (pp. 108–132). New York: Springer.

Hertzog, C., & Dunlosky, J. (2011). Metacognition in later adulthood: Spared monitoring can benefit older adults' self-regulation. *Current Directions in Psychological Science, 20*, 167–173.

Hertzog, C., Dunlosky, J., Robinson, A. E., & Kidder, D. P. (2003). Encoding fluency is a cue used for judgments about learning. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 29*, 22–34.

Karpicke, J. D. (2009). Metacognitive control and strategy selection: Deciding to practice retrieval during learning. *Journal of Experimental Psychology: General*, *138*, 469–486.

Kornell, N., & Bjork, R. A. (2008). Optimizing self-regulated study: The benefits and costs of dropping flashcards. *Memory*, *16*, 125–136.

Kornell, N., & Metcalfe, J. (2006). Study efficacy and the region of proximal learning framework. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *32*, 609–622.

McGillivray, S., & Castel, A. D. (2011). Betting on memory leads to metacognitive improvement by younger and older adults. *Psychology and Aging, 26*, 137–142.

Metcalfe, J. (2002). Is study time allocated selectively to a region of proximal learning? *Journal of Experimental Psychology: General*, *131*, 349–363.

Miles, J. R., & Stine-Morrow, E. A. L. (2004). Adult age differences in self-regulated learning from reading sentences. *Psychology and Aging*, *19*, 626–636.

Naveh-Benjamin, M., Brav, T. K., & Levy, O. (2007). The associative memory deficit of older adults: The role of strategy utilization. *Psychology and Aging*, *22*, 202–208

Nelson, T. O., Dunlosky, J., Graf, A., & Narens, L. (1994). Utilization of metacognitive judgments in the allocation of study during multitrial learning. *Psychological Science*, *5*, 207–213.

Nelson, T. O., & Leonesio, R. J. (1988). Allocation of self-paced study time and the "labor-in-vain effect." *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *14*, 676–686.

Paivio, A., Smythe, P. C., & Yuille, J. C. (1968). Imagery versus meaningfulness of nouns in paired-associate learning. *Canadian Journal of Psychology*, *22*, 427–441.

Son, L. K. (2004). Spacing one's study: Evidence for a metacognitive control strategy. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *30*, 601–604.

Son, L. K., & Metcalfe, J. (2000). Metacognitive and control strategies in study-time allocation. *Journal of Experiment Psychology: Learning, Memory, and Cognition*, *26*, 204–221.

Son, L. K., & Sethi, R. (2006). Metacognitive control and optimal learning. *Cognitive Science*, *30*, 759–774.

Souchay, C., & Isingrini, M. (2004). Age-related differences in the relation between monitoring and control of learning. *Experimental Aging Research, 30*, 179–193.

Stine-Morrow, E. A. L., Loveless, M. K., & Soederberg, L. M. (1996). Resource allocation in on-line reading by younger and older adults. *Psychology and Aging*, *11*, 475–486.

Stine-Morrow, E. A. L., Shake, M. C., Miles, J. R., & Noh, S. R., (2006). Adult age differences in the effects of goals on self-regulated sentence processing. *Psychology and Aging*, *21*, 790–803.

Thiede, K. W., & Dunlosky, J. (1999). Toward a general model of self-regulated study: An analysis of selection of items for study and self-paced study times. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 25*, 1024–1037.

Thiede, K. W., Anderson, M. C. M., & Therriault, D. (2003). Accuracy of metacognitive monitoring affects learning of texts. *Journal of Educational Psychology*, *95*, 66–73.

Tullis, J. G., & Benjamin, A. S. (in press). The effectiveness of updating metacognitive knowledge in the elderly: Evidence from metamnemonic judgments of word frequency. *Psychology and Aging*.

Tullis, J. G., & Benjamin, A. S. (2011). On the effectiveness of self-paced learning. *Journal of Memory and Language*, *64*, 109–118.

Tullis, J. G., Finley, J. R., & Benjamin, A. S. (2012). *Metacognition of the testing effect: When do learners predict the benefits of retrieval?* Manuscript under review.