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Self-Regulated Learning in Younger and Older Adults: Does Aging Affect Metacognitive Control?

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Abstract

Two experiments examined whether younger and older adults' self-regulated study (item selection and study time) conformed to the region of proximal learning (RPL) model when studying normatively easy, medium, and difficult vocabulary pairs. Experiment 2 manipulated the value of recalling different pairs and provided learning goals for words recalled and points earned. Younger and older adults in both experiments selected items for study in an easy-to-difficult order, indicating the RPL model applies to older adults' self-regulated study. Individuals allocated more time to difficult items, but prioritized easier items when given less time or point values favoring difficult items. Older adults studied more items for longer but realized lower recall than did younger adults. Older adults' lower memory self-efficacy and perceived control correlated with their greater item restudy and avoidance of difficult items with high point values. Results are discussed in terms of RPL and agenda-based regulation models.

Self-regulated learning involves metacognitive monitoring and control (Howard-Rose & Winne, 1993), including processes such as monitoring item difficulty, item selection, and study time allocation (Metcalfe & Kornell, 2005; Nelson & Narens, 1990). When presented with to-be-learned material, individuals can guide study according to what they currently know and do not know, such as by selecting items that are not already known for restudy (Metcalfe & Kornell, 2005). After items are selected, individuals can monitor their progress and determine how much time will be allocated to each item and when to cease studying. The ability to accurately monitor states of learning and to use monitoring outcomes to guide item selection and study time affect later recall of the material (Thiede, 1999).

Few studies have examined whether age-related differences exist in self-regulated learning. Dunlosky and Hertzog (1997) found that both younger and older adults restudied items they had rated as less well known. Dunlosky and Connor (1997) found that compared to younger adults, older adults produced lower within-person correlations of metacognitive judgments with study time, suggesting a possible deficit in using monitoring to control study (see also, Souchay & Isingrini, 2004). Moreover, controlling for the allocation of study time reduced the negative age-recall relationship, suggesting a possible functional consequence of the age-related differences in self-regulation. In contrast, Hines, Touron, and Hertzog (2009) found that older adults showed no deficit in using memory monitoring to control learning. In

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particular, both younger and older adults studied items longer that they had given lower confidence ratings on the preceding test.

All the studies just cited suggest learners focus new learning efforts more on the least well known items, a finding consistent with the discrepancy reduction model (DRM; Dunlosky & Hertzog, 1998; Nelson & Leonesio, 1988; Thiede & Dunlosky, 1999) of self-regulated learning. DRM predicts that individuals will focus on more difficult than on easier items, because it takes longer to reduce the discrepancy between the current state of learning and one's overall goal for more difficult than easier items (Dunlosky & Hertzog, 1998). Consistent with this possibility, many studies have found individuals choose to focus restudy time more on difficult, and presumably less well learned, items (Son & Metcalfe, 2000).

Metcalfe's (2002) competing region of proximal learning (RPL) model grades unknown items in terms of their difficulty to learn. RPL agrees that individuals will focus on unknown items, but by first selecting the unknown items that are closest in difficulty to their current level of mastery –their RPL. Specifically, the RPL model predicts that variables such as item difficulty, expertise of the participant, number of study trials, and total study time available should affect the selection of items to which time is allocated and the susceptibility of the items to learning gains. As individuals learn, they are expected to shift toward the study of items of progressively greater difficulty. Consistent with these predictions, Son and Metcalfe (2000) found that individuals selected easier items under time pressure than they did when given larger amounts of study time. In addition, Metcalfe (2002) found that children and younger adults unfamiliar with Spanish (i.e., novices) focused their time on easy and medium (i.e., moderately difficult) items, transitioning to difficult ones when time constraints allowed. In contrast, experts focused on difficult (and medium) items regardless of time constraints. Metcalfe and Kornell (2005) found that people attempt to eliminate items they already know, but then proceed from easier to the more difficult rather than the reverse, consistent with the RPL model and inconsistent with the DRM.

Although Metcalfe and colleagues (Kornell & Metcalfe, 2006; Metcalfe, 2002; Metcalfe & Kornell, 2003, 2005) have consistently observed the easy to difficult selection order, their research has only used samples of younger adults, leaving open the question whether older adults presented with items that vary in difficulty level would also select items in this order. One possibility is that there are age deficits in the ability to assess item difficulty a priori, a deficiency in initial item assessment. Another possibility is that older adults could in principle assess item difficulty, but do not do so. In contrast to these possibilities, the available evidence (Dunlosky & Hertzog, 1997) suggests that older adults do select items they do not know for restudy and devote more time to items they did not remember earlier (Hines et al., 2009). However, older adults might not identify items in their RPL and instead choose to focus on any unknown items without attending to their difficulty. Finally, older adults with low memory self-efficacy might avoid selecting difficult items if they believe they are unable to learn them, which could lead them to set lower task goals or have lower motivation than do younger adults (e.g., West, Thorn, & Bagwell, 2003). In effect, older adults might set a criterion for selecting items that is below the difficulty level of items that they could otherwise learn. All these possibilities predict that older adults would not show the same RPL effects as younger adults.

We conducted two experiments to examine whether younger and older adults would select easier unknown items first, as predicted by the RPL model, or would instead select only the less well known (most difficult) items as predicted by the DRM. If RPL predictions hold then younger and older adults should initially select easy unknown items for study. We also explored two other classes of explanations that could account for any tendency for older adults not to engage in RPL-consistent selection behavior.

First, we evaluated whether an age difference in the accuracy of assessing item difficulty would impair RPL-consistent selection behavior in older adults. If older adults do not evaluate item difficulty effectively, they could not be expected to manifest RPL effects. We collected ease-of-learning judgments (EOLs; Nelson & Narens, 1990), which measure peoples' pre-study assessment of the likely difficulty of learning a new Spanish vocabulary word. Because Kornell and Metcalfe (2006) collected difficulty norms for their items, we could correlate EOLs with normative difficulty (e.g., Leonesio & Nelson, 1990). We hypothesized that younger and older adults would show equivalent EOL-difficulty correlations, ruling out age differences in assessing difficulty as the explanation for age differences in the utilization of monitoring.

Second, age-related differences in self-regulatory behaviors could emerge if younger and older adults enter the task with different learning goals that make them more or less likely to select items based on item difficulty. Specifically, age-related reductions in memory self-efficacy might make older adults hesitant to study difficult items. Given Thiede and Dunlosky's (1999; see also Dunlosky & Thiede, 2004) research detailing the impact of low and high learning goals on young adults' study behaviors it seemed necessary to assess participants' learning goals. The first experiment therefore examined whether age-related differences in self-determined learning goals would exist that might affect younger and older adults' item selection behaviors. In a second experiment we assigned experimenter-determined learning goals and manipulated the value of selecting easy or difficult items to investigate how the variables might impact item selection and self-regulated study. For instance, varying experimenter-assigned goals independently of item difficulty should reveal whether older adults are willing to study difficult items when there is a high reward for doing so. Castel, Benjamin, Craik, and Watkins (2002) examined the impact of recall value on study behaviors and found that older adults were more likely than were younger adults to selectively control their study and recall by focusing on the items worth more points. Age differences in recall were negligible for the highest value items, but became progressively larger as point values for items decreased (see also Castel, Farb, & Craik, 2007). Such findings suggest motivational variables might also impact older adults' study behavior. We also collected questionnaire measures of memory beliefs to evaluate whether any divergence from RPL correlated with memory self-efficacy.

Experiment 1

Dunlosky and colleagues found DRM-consistent choice and allocation behaviors using unrelated concrete-noun paired associates that were relatively homogeneous in difficulty (Dunlosky & Connor, 1997; Dunlosky & Hertzog, 1997). Metcalfe's RPL research has used very different materials -- items manifestly heterogeneous in difficulty, such as English-Spanish vocabulary pairs (Metcalfe, 2002; Metcalfe & Kornell, 2003; 2005). Thus, to evaluate possible age differences in RPL selection behavior, Experiment 1 also used Spanish vocabulary items.

We hypothesized that age differences in learning goals could lead to age differences in self-regulation. Participants' self-determined learning goals presumably reflect what they hope to achieve in the task and are therefore one indicator of how they might approach the learning task. Age-related differences in learning goals could lead to very different item selection and study time. For example, higher goals, by default, indicate a willingness to learn more difficult items, whereas lower goals could reflect a plan to focus solely on a limited number of items within a particular (e.g., easier) difficulty level. Although we are interested in whether age differences in learning goals might yield age differences in self-regulation, the examination of learning goals ignores whether it is adaptive for older adults to set lower learning goals than do younger adults. That is, if older adults recognize that they are less

likely to be able to remember all 72 items, then perhaps it would be more efficient for them to focus on the subset of items they believe they can recall. In such cases, setting lower learning goals (relative to younger adults) could reflect an accurate view of their abilities. Participants were therefore asked to state how many of the 72 items they hoped to learn after rating all the items in the EOL phase, but before studying them. We hypothesized older adults would set relatively lower learning goals than younger adults.

Method

Design—A 3 (Item difficulty: easy, medium, difficult) × 3 (Age group: younger 45 s, younger 90 s, older) design was used with item difficulty manipulated within subjects.

Participants—Sixty-four younger (30 males and 34 females) and 31 older adults (11 males and 20 females) participated. Younger adults (*M* age = 20.05 years, *SD* = 1.60) were psychology students at the Georgia Institute of Technology who received extra credit for participating. Older adult participants (*M* age = 69.16 years, *SD* = 5.27) were normal, community-dwelling adults recruited from Atlanta, Georgia who received a nominal fee. All were pre-screened to ensure they were neither a bilingual Spanish speaker nor had taken Spanish courses in high school or college. All participants were treated in accordance with APA ethical guidelines.

Materials—Seventy-five English-Spanish vocabulary pairs from Metcalfe (2002) were selected based on Kornell and Metcalfe's (2006) recall norms, stratified into sets of easy (e.g., aspirina – aspirin), medium (e.g., infrahumano – subhuman), and difficult items (e.g., anquilasamiento – stagnation). Spanish words served as cues, English equivalents as targets. This procedure allowed EOLs to be collected on the Spanish words alone rather than complete Spanish-English pairs, minimizing learning of the Spanish vocabulary when making EOLs.

Inquisit software, version 3.0.0.0 (2007), and desktop computers presented stimuli. Three vocabulary pairs were used for instructions. The remaining 72 pairs (24 from each difficulty level) were used as experimental stimuli for EOLs, pre-experimental knowledge testing, self-regulated learning, and post-study recall testing. Participants' recall responses were hand scored so that participants were not penalized for spelling errors.

The self-regulated learning phase presented items on 5 × 8 inch note cards with the Spanish cue on one side and the intact Spanish-English word pair on the other side. The note cards were arranged on a 24 × 36 inch bulletin board with items segregated by difficulty level (see below). The experimenter recorded the order in which items were (re)selected and how much time was allocated to an item.

Procedure—Participants were tested individually and completed demographic and memory beliefs (i.e., Personal Beliefs about Memory Inventory – PBMI; Lineweaver & Hertzog, 1998) questionnaires, a measure of working memory capacity (i.e., Listening Span task; Salthouse & Babcock, 1991) and an English vocabulary test (i.e., the Advanced Vocabulary Test – AVT; Ekstrom, French, & Harman, 1976), before beginning the criterion task. The PBMI scales included measures of perceived control over memory and memory self-efficacy. Participants provided EOLs for each Spanish word by typing a number using a 9-point Likert scale (1 = easy to learn, 9 = difficult). Participants then viewed each Spanish word again, typed their best guess as to what the English equivalent for the Spanish word was, and received immediate accuracy feedback ("correct" versus "incorrect") before the onset of the next word. This test provided an objective measure of pre-study Spanish knowledge. Participants then indicated what their global learning goal was (i.e., how many

items they hoped to be able to learn and correctly recall) out of 72 items before beginning the study phase.

During the study phase, eight different 3 × 3 grids containing the Spanish portion of three easy, three medium, and three difficult Spanish-English vocabulary pairs were presented. Participants were told where easy, medium, and difficult items were located within the grids and to select any items for which they wanted to see the intact vocabulary pair, as in Metcalfe and Kornell (2005). Participants selected items for study one at a time. A countdown clock was activated when the intact vocabulary pair was visible that gave older and half of the younger adults 90 s and the other half of younger adults 45 s per grid. Once participants indicated they were finished studying an item (or time ran out), the experimenter stopped the clock and recorded selection order and how much time was allocated to each item before the participant selected the next item. This process continued until either time elapsed or participants indicated they had (re)studied all the items within a grid they wished to study, even if time still remained, at which point the next grid was presented. Once participants viewed all eight grids they returned to the computer and provided delayed judgments of learning. These judgments are not discussed further because they are not relevant to item selection behaviors. Participants then completed the post-study recall test.

Results

Self-determined learning goals—A one-way analysis of variance (ANOVA) was used to test for differences in younger adults' self-determined learning goals as a function of how much time they had been told they would have to study items. Younger adults' goals did not differ as a function of allotted time (45 s: $M = 41.91$, $SE = 2.59$, versus 90 s: $M = 38.00$, $SE = 2.72$), $F(1, 62) = 1.08$, $p > .05$, $\eta_p^2 = .017$. We therefore combined the younger adults' data and ran another ANOVA with age group as the between subjects variable to examine whether age-related differences occurred in self-determined learning goals. Consistent with our hypothesis, older adults reported reliably lower learning goals ($M = 27.42$, $SE = 2.93$) on average than did younger adults, ($M = 39.95$, $SE = 1.88$), $F(1, 93) = 13.75$, $p < .001$, $\eta_p^2 = .129$. Thus, older adults entered the learning task expecting to achieve less, on average, than younger adults. We next examined whether these age-related differences in goals yielded differences in item selection or study time.

Item selection order—We followed Metcalfe and Kornell's (2005) procedure for evaluating participants' item selection behaviors. We excluded items that had been given correct answers on the pre-study recall test.[1] All remaining items that were normatively classified as easy were assigned a value of "1", medium items a value of "2", and difficult items a value of "3". The mean of all items selected first was then calculated (aggregating over the grids), as was the mean for the second through ninth selections.

If participants selected easier items first, as the RPL model predicts, then the mean of the first selection should be a number close to 1. Consistent with RPL predictions, Figure 1 shows that participants in both age groups selected easier items first, and then over the following selections slowly transitioned to selecting more difficult items. Reliable age differences existed in the difficulty level of selected items for the third, $F(1, 47) = 4.50$, $p < .05$, $\eta_p^2 = .087$, fourth, $F(1, 69) = 10.01$, $p < .01$, $\eta_p^2 = .127$, fifth, $F(1, 73) = 15.77$, $p < .001$, $\eta_p^2 = .178$, and sixth selections, $F(1, 51) = 9.95$, $p < .01$, $\eta_p^2 = .163$, because younger

[1]Because many of the easy Spanish words were cognates, younger and older adults in both experiments were able to correctly guess what many of the easy Spanish words meant before studying them. Thus most easy items were eliminated for most people in the analysis of selection order.

adults selected on average more difficult items than did older adults. The other selections did not differ reliably across age groups.

Item reselection behaviors—Participants' selection behaviors were examined further for time- and difficulty-related differences in the items younger and older adults chose to study more than once. As may be seen in Table 1, reselections became more prevalent as difficulty level increased and older adults restudied items more than did younger adults. Older adults were more likely than younger adults to restudy easy, F (1, 93) = 10.13, $p < .01$, $\eta_p^2 = .098$, medium, F (1, 93) = 20.26, $p < .001$, $\eta_p^2 = .179$, and difficult items twice, F (1, 93) = 11.26, $p < .01$, $\eta_p^2 = .108$. Younger adults given 90 s reselected items at a higher rate than did those given 45 s, but the difference was only reliable for difficult items, F (1, 62) = 5.55, $p < .05$, $\eta_p^2 = .082$.

The differences in younger adults' behaviors likely reflect the impact of time constraints, whereas the age differences could reflect older adults' desire to double check their memory of a word's meaning, an inability to remember that they had already studied the item, or both. We calculated correlations between reselection behaviors and participants' memory belief ratings as well as between reselections and participants' working memory capacity (WMC) and vocabulary scores to indirectly address these possibilities. We found that older adults with lower memory self-efficacy and lower WMC scores were more likely to avoid difficult items, not selecting them at all, $r = -.43$ and $r = -.42$, respectively. English vocabulary skills and WMC both correlated positively with the tendency to ignore easy items ($r = .69$, and $r = .43$, respectively) and negatively with selecting easy items once ($r = -.69$, and $r = -.47$), suggesting that those with better vocabularies may have been better able to identify the cognates and those higher in WMC may have been better able to retain whether their pre-study recall test responses for these easier items had been correct. Older adults' beliefs about their ability to control their memory correlated with their tendency to restudy items, with those with lower control beliefs being more likely to restudy moderately difficult items ($r = -.37$), and those with higher perceived control over memory and higher memory self-efficacy being less likely to restudy difficult items (control $r = -.39$; memory self-efficacy $r = -.42$). The pattern of correlations thus suggests that older adults' (re)selection behaviors were more likely due to concerns about memory (i.e., memory beliefs) as opposed to memory per se.

EOL accuracy—To determine whether older adults are deficient in assessing item difficulty, we examined whether participants' EOLs for items that were not known on the prestudy recall test aligned with the Kornell and Metcalfe (2006) difficulty categories. We used repeated measures analyses with difficulty level as the within subjects variable and age as the between subjects variable to test for age differences in subjective item difficulty (i.e., EOLs). Table 2 demonstrates that older adults rated items of each type as reliably more difficult than did younger adults, F (1, 93) = 20.30, $p < .001$, $\eta_p^2 = .179$. A large effect of item Difficulty was observed, F (2, 92) = 535.51, $p < .001$, $\eta_p^2 = .921$, but the Age × Difficulty interaction was not reliable, F (2, 92) = 1.74, $p > .05$, $\eta_p^2 = .036$.

To further examine the accuracy of participants' EOLs, we computed Goodman-Kruskal gamma correlations of EOLs with normative difficulty. These intraindividual correlations assess resolution of the judgments (Nelson, 1984), in this case, how well participants' subjective impressions of difficulty align with normative difficulty at the item level. Younger adults had slightly higher resolution than did older adults, but the difference was not reliable (younger $M = .75$, $SE = .01$ versus older $M = .69$, $SE = .04$), t (94) = 1.69, $p > .05$.These results rule out the hypothesis that older adults cannot accurately assess item difficulty.

EOLs and selection behaviors—Participants' subjective impressions of item difficulty could influence their selection behaviors. We therefore examined whether EOLs for studied items were different than those for ignored items. On average, participants selected items they perceived as more difficult (*M* EOL of items selected = 5.48, *SE* = .04), and ignored easier items (*M* EOL of items ignored = 4.34, *SE* = .05). Age-related differences existed in the overall pattern of selections (see Table 3). Older adults selected items they had rated as more difficult and ignored easier items within the normatively easy, medium, and difficult categories. Younger adults also selected items perceived as more difficult within the easy category, but tended to select on average easier items and ignore more difficult items within the medium and difficult categories. Thus younger adults' selection behaviors were consistent with the RPL model's prediction that people seek to exclude known items to instead focus on the subset of unknown items they believe they can learn. In contrast, older adults' selections appeared less sensitive to subjective differences in item difficulty.

Additional analyses indicated that both younger and older adults relied more on normative difficulty than subjective difficulty when selecting items (younger: t (63) = 11.78, $p < .001$, and older: t (30) = 9.11, $p < .001$). That is, gamma correlations calculated between selection order and either normative or subjective difficulty (i.e., EOLs) revealed that younger adults' selection order correlated more highly with normative difficulty (45 s *G* = .68, *SE* = .09, and 90 s *G* = .73, *SE* = .08) than with item level EOLs (45 s *G* = .31, *SE* = .06, and 90 s *G* = .32, *SE* = .04), as did older adults' (normative *G* = .84, *SE* = .05, and subjective *G* = .39, *SE* = .04). Thus, older adults' subjective impressions of item difficulty were slightly less accurate than younger adults', yet because both younger and older adults relied more on normative than subjective difficulty when selecting items, both age groups selected easier items first.

Study time—For completeness, we also examined how individuals allocated their time across items. Younger adults who were allotted 45 s per grid (360 s total) studied items on average for 280.09 (*SE* = 12.66) s, which was reliably less time than the 416.19 (*SE* = 33.93) s that younger adults given 90 s per grid (720 s total) spent studying items, F (1, 62) = 14.12, $p < .001$, $\eta_p^2 = .186$. Older adults' average overall study time 471.48 (*SE* = 36.72) s did not differ reliably from the younger adults' study time who also received 90 s per grid, F (1, 62) = 1.23, $p > .05$, $\eta_p^2 = .020$, but was reliably greater than younger adults' study time when given 45 s per grid, F (1, 93) = 10.36, $p < .01$, $\eta_p^2 = .207$. The observed differences in overall study time were thus based more on how much time participants were allocated rather than age per se. Only one younger adult in the 45 s group and one older adult used all their allotted time. Thus, having additional study time did not mean that individuals chose to use it.

Because of these age- and time-related differences in study time we focused on whether individuals in each age and time group allocated the same proportion of time to items in each difficulty level. To examine this issue, the amount of time participants allocated to items of each type was divided by the total amount of time they spent studying all items (see Table 4).[2] These values for each difficulty level were then subjected to a MANOVA with age and allotted time as the between subjects variables. These analyses revealed a reliable main effect of Age, F (2, 91) = 12.24, $p < .001$, $\eta_p^2 = .212$, but no main effect Time, F (2, 91) = 1.65, $p > .05$, $\eta_p^2 = .035$. The Age × Time interaction was not interpretable because these two variables were confounded for younger adults in the 90 s condition. Follow-up analyses indicated that older adults allocated proportionally more time to easy items, F (1, 92) = 21.19, $p < .001$, $\eta_p^2 = .187$, and medium items, F (1, 92) = 11.47, $p < .01$, $\eta_p^2 = .111$, than did younger adults in either time condition. Conversely, younger adults allocated

[2]Actual time spent studying all items rather than allotted time (i.e., either 45 or 90 s per grid) was used as the denominator because not all participants chose to use all of their allotted time.

reliably more time to the difficult items than did older adults, F (1, 92) = 18.01, $p < .001$, $\eta_p^2 = .164$. However, young adults given 45 s allocated a reliably larger percentage of their time to medium items relative to younger adults given 90 s, F (1, 62) = 5.54, $p < .05$, $\eta_p^2 = .082$, whereas young adults given 90 s allocated more time to difficult items than did those given less time, F (1, 62) = 6.46, $p < .05$, $\eta_p^2 = .094$. Thus, younger and older adults *selected* items in a similar manner (i.e., easiest first), but *allocated time* differently. Yet, on average all participants allocated more time to difficult than easier items.

Recall performance—Table 5 reports the mean performance on the pre-study and post-study recall tests. Younger adults' pre-study recall performance indicated they either knew more Spanish words upon entering the experiment or were more adept than older adults at guessing what the Spanish words meant, F (1, 93) = 16.73, $p < .001$, $\eta_p^2 = .152$. This was especially true for easy items, F (1, 93) = 21.00, $p < .001$, $\eta_p^2 = .184$, many of which were cognates. However, no age-related differences existed for medium items because participants in both age groups were unlikely to know or correctly guess their meaning, $F < 1$. Pre-study recall of difficult items was zero for both age groups.

Younger adults recalled more Spanish words overall than did older adults on the post-study recall test, t (94) = 6.45, $p < .001$. Younger adults recalled more than did older adults within each difficulty level, F (3, 91) = 15.93, $p < .001$, $\eta_p^2 = .344$.

Discussion

Experiment 1 provides the first evidence to date that older adults, like younger adults, select items in a manner consistent with the RPL model when presented with items of heterogeneous difficulty. Individuals in both age groups tended to select normatively easier items ahead of more difficult items for study. This selection order was found despite older adults' tendency to view all items as subjectively more difficult and their being less able to guess the meaning of the easy Spanish words before study than younger adults. However, older adults were somewhat more likely to restudy items that were easy, relative to those that were difficult.

Older adults were not appreciably different from younger adults in their prestudy assessment of item difficulty, as measured by EOLs. This finding rules out an age-deficit in assessing item difficulty as an explanation for older adults' tendency to restudy easy and medium items more than did younger adults.

Older adults also allocated study time to items within each difficulty level differently. Given that older adults knew fewer easy items before study, it is perhaps not surprising that they spent reliably more time on easy and medium items than did younger adults, whereas younger adults allocated reliably more time to difficult items than did older adults. However, 45 s younger adults prioritized studying medium items more than did 90 s younger adults, showing that age and time constraints impact the likelihood of individuals focusing on more difficult items that might be outside their RPL. Moreover, the fact that older adults set lower performance goals for themselves suggests an alternative explanation, namely, that they were more focused on learning items they thought were in the range of their possible RPL. Thiede and Dunlosky (1999; see also Dunlosky & Thiede, 2004) noted that when given lower learning goals, younger adult participants selectively restudied a few items rather than seeking mastery of the full list and therefore obtained lower recall; thus it seems possible that the small differences in older adults' selection of items for restudy and their study time allocation could be due to the older adults setting lower learning goals for themselves as opposed to age-related changes in metacognitive control or memory. Consistent with this hypothesis, in the older adult sample, lower memory self-efficacy was correlated with restudy behavior.

Older adults had much lower recall than did younger adults, despite using more of the available time and selecting items for study in a similar easy to difficult order. These age-related differences in recall could reflect poor metacognitive self-regulation, in terms of either which items are selected for (re)study or in terms of inefficient use of allocated study time. The results of Experiment 1 suggest that initial study selections are not the issue. It is possible that restudy behaviors and study time allocation by older adults that tended to favor easy and medium items over difficult items may have contributed to the differences.

Experiment 2

Experiment 2 sought to clarify the relationship between learning goals, self-regulated study, and recall performance. Of interest was whether simultaneously providing participants with a second dimension of item selection -- namely, item point values -- would differentially alter selection strategies for younger and older adults. The joint manipulation of value and difficulty presents older adults with an interesting decision. On the one hand, older adults recall less than do younger adults; to achieve experimenter-set performance goals older adults might need to focus on high-value items, regardless of difficulty (e.g., Castel et al., 2002). On the other hand, older adults could experience diminishing returns when studying difficult items, no matter what the items' value, thus faring better if they focused on learning as many high-value easy and medium items as possible. Finally, even if older adults benefit from studying difficult items (as recall results from Experiment 1 suggest), older adults might avoid difficult items of high value because they have low memory self-efficacy (e.g., Berry & West, 1993; see Hertzog & Hultsch, 2000), which apparently influenced restudy behavior in Experiment 1.

We simultaneously manipulated item difficulty and point value, providing younger and older adults with grids that either (a) valued easy items (i.e., promoted an RPL-consistent selection order), (b) were neutral with respect to difficulty, or (c) valued difficult items (i.e., promoted a DRM-consistent selection order). We also manipulated the nature of experimenter-provided goals by providing instructions that stressed the number of words recalled, the number of points earned, or both. The issue of interest was how well participants in each age group would be able to exert metacognitive control over their study behaviors to earn points.

Method

Design—The experiment was a 4 (Goal type: High word/High point, High word/Low point, Low word/High point, or Low word/Low point goal) × 3 (Item difficulty: easy, medium, and difficult) × 3 (Point values: favor recall of easy items, difficult items, or are neutral) × 3 (Age group: younger 30 s, younger 60 s, and older) × 2 (Point order: easy items valued first versus difficult items valued first) design. All factors except age group and point order were manipulated within subjects. Goal type was fully crossed with the point value and item difficulty factors such that for each goal participants were asked to study three different 2 × 3 grids, each containing two easy, two medium, and two difficult Spanish-English vocabulary pairs. The vocabulary pairs had point values associated with them that either initially favored recall of the easy items (i.e., more points to easy items), difficult items (i.e., more points to difficult items), or were neutral (i.e., did not favor recall of items from any particular difficulty level; see Figure 2). Thus each of the four goal types had three grids, one with each type of point structure, associated with it to allow examination of how well individuals were able to adapt their item selection and study time allocation behaviors to achieve the experimenter-provided goals (see Figure 3).

Participants—Sixty younger (33 males and 27 females) and 31 older adults (10 males and 21 females) participated in the experiment. Younger (*M* age = 19.57 years, *SD* = 1.50) and

older adult participants (*M* age = 68.74 years, *SD* = 4.78) were recruited, compensated, and pre-screened for Spanish exposure as in Experiment 1. Participants were tested in groups of up to seven people, but younger and older adults were tested separately.

Random assignment of the younger adults resulted in 31 participants in the 30 s and 29 in the 60 s group. All older adults were given 60 s. Participants within these age/time groups were further subdivided randomly into either an Easy-Neutral-Difficult (Easy First) or Difficult-Neutral-Easy (Difficult First) Point Order group (see Figure 2). Participants randomly assigned to the Easy First point order initially viewed a grid whose point values favored recall of easy items before seeing the neutral and final grid which favored recall of the most difficult items. Those randomly assigned to the Difficult First point order viewed grids in the opposite (i.e., favor difficult, neutral, favor easy) order (see Figure 3). Thirty-three younger and 13 older adults received the Easy First point order and 27 younger and 18 older adults received the Difficult First point order. Although point order was not expected to matter, the two orders were included to examine order effects, albeit with a small number of participants in each order.

Materials—The same 75 Spanish-English word pairs were used in Experiment 2. Of the 72 experimental items, one third of the items within each difficulty level were assigned point values that favored recall of difficult items, one third point values that favored easy items, and the remaining third were given point values that were neutral (see Figure 2). This allowed the creation of 12 different 2 × 3 grids, 4 for each type of point distribution, to be used during the encoding phase. Two items of each difficulty type were randomly selected to appear in each of 12 different 2 × 3 grids. Three grids were associated with each of the four experimenter-determined goals which specified how many words the participant should strive to recall and how many points they should try to earn by recalling those words. The word goal (i.e., how many words they should try to recall) was designed to either require recall of a high number of words (i.e., try to recall 9 of the 18 vocabulary pairs) or a low number of words (i.e., try to recall 4 of the 18 vocabulary pairs). The point goal (i.e., how many points they should try to earn) was also either high or low. Word recall goals (high and low) were crossed with the point goals (high and low) to obtain four distinct task goals.

The *High word/High point* goal instructed participants to try to recall nine words and obtain 80 points. The high (word and point) goals were designed to try and force participants to study items of varying difficulty levels from multiple grids rather than just one grid in order to achieve the goal. The *High word/Low point* goal required nine words and 42 points whereas the *Low word/High point* goal required four words and 44 points, and the *Low word/Low point* goal required four words and 12 points. Although each point goal could be pursued in a variety of ways (e.g., recalling a single easy 12-point item in the low point goal condition), participants were somewhat constrained by the corresponding word goal such that to achieve both parts of the goal, they had to take into account both how many words they should study/recall, but also the point values associated with those items, thus requiring even greater metacognitive control.

All phases of the criterion task were computerized. Instructions and stimuli were presented on the computer screen and responses were input using the mouse and keyboard. The computer program, developed in C# (Microsoft Visual Studio, Version, Microsoft Corporation, 2005), recorded participants' responses to all queries, the order in which items were (re)selected, how much time was allocated to each item, and with which of the four goals the items were associated. Participants' recall test responses were hand scored as in Experiment 1.

Procedure

Participants were given the same measures as in Experiment 1 before beginning the experimental task. Participants were informed about the study phase and told to recall enough items to achieve all four experimenter-determined point or word recall goals. They were told the point values would change across the grids associated with each goal, but that left-to-right difficulty ordering within each grid would remain constant.

Participants were presented one of the four goals, in a random order, one at a time. They were asked to repeat the point and word portions of the goal by typing the correct numbers before being allowed to proceed. The questions were designed to ensure participants understood the meaning of the points and goals. Once the study phase began the goal was displayed to insure that individuals did not forget it. The Spanish word and the associated point value for recall appeared in the grids.

Participants selected an item by clicking on it, revealing a new screen containing the intact vocabulary pair. A clock also appeared, counting down until time elapsed or the participant terminated study. After participants provided a strategy report, the grid reappeared. The clock resumed countdown once the next item was selected. The process of presenting grids repeated until time elapsed on the three grids associated with each of the four goals, or participants terminated study for that goal. After study was complete, participants were given a recall test.

Results

Item selection order—Item selection order was coded as before, and then averaged for participants' first six selections, collapsing across the 12 grids.[3] Consistent with Experiment 1, both younger and older adults selected easier items first and only later transitioned to more difficult items (see Figure 4). We calculated ANOVAs for each of the first six selections to examine whether age differences existed in the difficulty level of items selected, but only the second, F (1, 85) = 7.39, $p < .01$, $\eta_p^2 = .080$, and third selections, F (1, 87) = 3.95, $p = .05$, $\eta_p^2 = .043$, were reliably different for younger and older adults.

Individuals in both age groups and point orders (i.e., Easy First versus Difficult First) selected items in an easy to difficult order, as manifested in a reliable linear trend, F (1, 46) = 97.28, $p < .001$, $\eta_p^2 = .679$ (see Figure 4). Those who had received the Difficult First point order, in which points initially favored the most difficult items, first selected items reliably more difficult than did those given the Easy First point order, (M = 2.08, SE = .11 versus M = 1.79, SE = .09, respectively), F (1, 79) = 4.79, $p < .05$, $\eta_p^2 = .057$. Yet because difficulty level only differed reliably for the first selection for both age groups, the main effect of point order and the Age × Order interaction were not reliable, $F < 1$.

Item reselection behaviors—We examined whether participants' reselection behaviors varied as a function of age, time constraints, or item difficulty level (see Table 1). Age, but not time, differences existed in participants' tendency to restudy easy items, F (1, 89) = 15.40, $p < .001$, $\eta_p^2 = .148$. There were also reliable age differences for medium, F (1, 89) = 6.37, $p < .05$, $\eta_p^2 = .067$, and difficult items, F (1, 89) = 5.42, $p < .05$, $\eta_p^2 = .057$, because older adults reselected more of these items more frequently than did younger adults.

As in Experiment 1, we examined whether there was a relationship between older adults' tendency to reselect items and either memory beliefs, WMC, or vocabulary skills. We again

[3]The mean level of difficulty was examined for only the first six, rather than nine, items selected because grids in Experiment 2 only contained six items versus the nine item grids in Experiment 1.

found that older adults with lower memory self-efficacy were more likely to restudy easy items three times ($r = -.72$). Those with lower vocabulary scores were more likely to study easy items a single time ($r = -.72$), whereas those with higher vocabulary and WMC scores were more likely to ignore easy items ($r = .68$ and $r = .41$, respectively), probably because the latter were better able to decipher the easy cognates.

EOL accuracy—A reliable main effect of difficulty, F (2, 88) = 207.01, $p < .001$, $\eta_p^2 = .825$, indicated that EOLs aligned with normative difficulty (Table 2). Older adults viewed items of all types as more difficult than did younger adults, F (1, 89) = 35.06, $p < .001$, $\eta_p^2 = .283$.

The gamma correlations of EOLs with normative difficulty were large for both age groups, indicating both younger and older adults' EOLs increased as normative difficulty increased. The correlations were slightly higher for younger adults, but the difference was not reliable (younger $M = .73$, $SE = .03$ versus older $M = .64$, $SE = .05$), t (89) = 1.46, $p > .05$. As in Experiment 1, selection order correlated more strongly with normative than subjective difficulty (i.e., EOLs) for younger (30 s $G = .58$, $SE = .08$ versus $G = .41$, $SE = .06$; 60 s $G = .65$, $SE = .07$ versus $G = .35$, $SE = .08$), t (59) = 7.63, $p < .001$, and older adults ($G = .53$, $SE = .10$ versus $G = .32$, $SE = .09$), t (30) = 7.27, $p < .001$.

EOLs and selection behaviors—We compared EOLs for selected and ignored items and found that participants on average selected items they perceived as more difficult (M of items selected = 5.83, $SE = .11$), and ignored easier items (M of items ignored = 5.77, $SE = .13$). Younger and older adults selected subjectively more difficult items within the normatively easy category, but subjectively easier (or similar) items within the medium and difficult categories (see Table 6). Thus younger adults' selection pattern replicated Experiment 1. Older adults' selections differed from Experiment 1 in which older adults had selected subjectively difficult and ignored easier items across all three difficulty levels. We examined whether the experimenter-provided goals in Experiment 2 might account for the discrepancy in older adults' selections across the two experiments. However, younger and older adults' selections indicated they selected subjectively easier items and ignored items they perceived to be more difficult across all difficulty levels, regardless of goal demands (see Table 7).

Study time allocation—None of the participants used all of their allotted time. On average 30 s younger adults used 140.15 ($SE = 13.01$) s of their 360 s total time whereas 60 s younger adults spent 151.03 ($SE = 22.89$) s and older adults 358.79 ($SE = 26.18$) s of their 720 s total time. The majority of participants used less than half of their allotted time, but older adults used reliably more time than did younger adults, F (1, 89) = 67.77, $p < .001$, $\eta_p^2 = .432$.

Analyses examining the proportion of time allocated to items within each difficulty level indicated that younger and older adults allocated time differently (see Table 4). Older adults allocated a reliably larger percentage of their time to easy items than did younger adults, F (1, 89) = 11.12, $p < .01$, $\eta_p^2 = .111$. Older adults also allocated a larger percentage of their time to medium items than did younger adults, but the difference was not reliable, F (1, 89) = 3.79, $p = .06$, $\eta_p^2 = .041$. In contrast, younger adults allocated more of their time to difficult items, compared to older adults, F (1, 89) = 15.01, $p < .001$, $\eta_p^2 = .144$. Thus older adults allocated more time to easy and medium items whereas younger adults focused a larger percentage of their time on the most difficult items.

Recall—Pre-study recall performance was reliably better for younger than for older adults, ($M = .30$, $SE = .01$ versus $M = .23$, $SE = .01$, respectively), F (1, 89) = 32.31, $p < .001$, $\eta_p^2 =$.

266. The post-study test indicated that younger adults recalled more overall and for all three difficulty levels than did older adults, F (3, 87) = 12.77, $p < .001$, $\eta_p^2 = .306$ (see Table 8). Because older adults showed no discrepancy in recall as a function of point value ($M = .38$, $SE = .03$ for high and $M = .37$, $SE = .03$ for low) the age-related differences in recall held for low (i.e., 2, 4, or 6 point), F (1, 89) = 23.55, $p < .001$, $\eta_p^2 = .209$, and high valued (i.e., 8, 10, or 12 point) items, F (1, 89) = 30.58, $p < .001$, $\eta_p^2 = .256$. Yet, younger adults had better recall for high valued items ($M = .55$, $SE = .02$) than lower valued items ($M = .51$, $SE = .01$).

The order of exposure to point rewards influenced the impact of point value on recall performance. Those given the Easy First point order ($M = .53$, $SE = .02$ for high and $M = .50$, $SE = .02$ for low) recalled reliably more than did those given the Difficult First point order ($M = .45$, $SE = .02$ for high and $M = .42$, $SE = .02$ for low) for both high, F (1, 89) = 6.33, $p < .05$, $\eta_p^2 = .066$, and lower valued items, F (1, 89) = 6.61, $p < .05$, $\eta_p^2 = .069$. For younger adults, recall was 7% higher in the Easy First than in the Difficult First order for both low and high valued items. Older adults that received the Easy First order had slightly higher recall and showed more differentiation in their recall for high and low point items ($M = .41$, $SE = .05$ for high and $M = .39$, $SE = .03$ for low) than did those that received the Difficult First order ($M = .36$, $SE = .03$ for high and $M = .36$, $SE = .04$ for low), but the differences were not reliable, $F < 1$. Thus, recall was higher in the Easy First group than in the Difficult First group for both age groups, but younger adults showed differentiation between recall of high and low valued items regardless of order, whereas older adults did not.

A MANOVA indicated that age-related differences existed in recall for all four goals because older adults recalled reliably less than did younger adults, F (4, 86) = 9.03, $p < .001$, $\eta_p^2 = .296$. As illustrated in Figures 5 and 6, the trend across all four goals was for older adults to attempt more but achieve less than did younger adults. To examine these trends, repeated measures analyses were conducted in which either attempted or achieved words or points for each goal were treated as the within subjects factor and age as the between subjects factor. The between subjects analyses examining age differences revealed that older adults did study more words, F (1, 89) = 3.80, $p = .054$, $\eta_p^2 = .041$, and attempt more points than did younger adults, F (1, 89) = 2.97, $p > .05$, $\eta_p^2 = .032$, but the differences were not reliable. However, younger adults did recall more words, F (1, 89) = 30.25, $p < .001$, $\eta_p^2 = .254$, and earn more points than did older adults, F (1, 89) = 31.86, $p < .001$, $\eta_p^2 = .264$. There was also a main effect of Goals, indicating that the number of words studied, F (3, 87) = 31.54, $p < .001$, $\eta_p^2 = .521$, and points attempted, F (3, 87) = 78.45, $p < .001$, $\eta_p^2 = .730$, varied as a function of the experimenter-determined goals participants were given, as did the number of words actually learned, F (3, 87) = 249.20, $p < .001$, $\eta_p^2 = .896$, and the number of points earned, F (3, 87) = 340.10, $p < .001$, $\eta_p^2 = .921$. The Goal × Age interactions for attempted words and points were not reliable, $F < 1$, and the interactions for actual words recalled and points earned only approached reliability, F (3, 87) = 2.64, $p = .054$, $\eta_p^2 = .083$, and F (3, 87) = 2.66, $p = .053$, $\eta_p^2 = .084$, respectively. Posthoc analyses revealed that the marginally reliable results for age-related differences in attempted words, F (1, 89) = 4.64, $p < .05$, $\eta_p^2 = .050$, and attempted points, F (1, 89) = 4.35, $p < .05$, $\eta_p^2 = .047$, were only reliable for the low word/low point goal. However, younger adults recalled more words, F (1, 89) = 15.27, $p < .001$, $\eta_p^2 = .146$, and achieved more points than did older adults, F (1, 89) = 15.52, $p < .001$, $\eta_p^2 = .149$, for the low/low goal. Younger adults also recalled more words, F (1, 89) = 29.97, $p < .001$, $\eta_p^2 = .252$, and earned more points than did older adults for the high word/low point goal, F (1, 89) = 30.84, $p < .001$, $\eta_p^2 = .257$. A similar pattern was found for the low word/high point goal, with reliable differences in words, F (1, 89) = 13.42, $p < .001$, $\eta_p^2 = .131$, and points, F (1, 89) = 14.34, $p < .001$, $\eta_p^2 = .139$, as well as the high word/high point goal, F (1, 89) = 31.64, $p < .001$, $\eta_p^2 = .015$, and F (1, 89) = 31.20, $p < .001$, $\eta_p^2 = .005$, respectively. Together, these data indicate that if the goals stressed points

(i.e., high point conditions), then increasing the word goal from low to high decreased the likelihood that younger and older adults would achieve the point portion of the goal. In contrast, if the goals stressed words (i.e., high word conditions), then increasing the point goal served to decrease the likelihood that the word goal would be achieved, more so for older than younger adults. This occurred despite the fact that individuals in both age groups (and time groups) were more likely to pursue the higher word goal when it was paired with the higher point goal. Thus individuals seemed to focus on whichever aspect of the goal was most potentially rewarding.

Discussion

Experiment 2 examined whether younger and older adults would select and allocate time to items in a RPL-consistent way, as in Experiment 1, or whether points and goals would alter study behaviors and provide evidence for age differences in metacognitive control. Older adults in the present experiment selected items in the same easy-to-difficult order as did younger adults, but allocated reliably more time to items than did younger adults. However, they had reliably lower recall performance than did younger adults for all items.

Point values and order did affect participants' selections. Thus, Easy First participants selected easier items first and Difficult First order participants selected slightly more difficult items first, in keeping with what the points were rewarding in each order. However, younger adults' selections and recall showed greater differentiation as a function of point order than did older adults' because older adults were less sensitive to point values in the Difficult First point order, which could be interpreted as an age difference in self-regulation keyed to avoidance of difficult items. Experiment 2 thus provided evidence that points, which were included to examine whether they would increase goal pursuit, goal achievement, and learning (i.e., recall performance), increased goal pursuit (but only when presented in an Easy First order), but actually seemed to hurt recall performance, which was lower than recall levels obtained in Experiment 1. More important, the impact of points and point order highlighted that RPL selection effects can be altered by performance goals.

General Discussion

Several key results expand our understanding of younger and older adults' self-regulated learning behaviors and raise questions for future research. First, older adults, like younger adults, initially select items in an easy to difficult order, showing that RPL effects also apply to older adults' item selection behaviors. Although this was the case, both experiments also showed that older adults may discount their ability to learn difficult items. They set lower learning goals and were more likely to restudy items that are easy and medium, rather than difficult. The strongest evidence in favor of this possibility derives from the point-value condition in Experiment 2 where difficult items were given the highest values. In that case, older adults' selections tended to favor easier items, regardless of point value. Although this age difference did emerge, the larger picture is that younger and older adults selected items in a RPL-consistent way, subject to the proviso that older adults were able to focus on easy and medium difficulty items. These findings contrast those obtained in experiments that have used items with less variability in difficulty level, in which younger and older adults selected items judged to be difficult rather than easy to learn (Dunlosky & Hertzog, 1997).

Ariel et al (in press) recently proposed an agenda-based regulation (ABR) model that indicates people's item selection should be interpreted with respect to the task goals and agendas that each participant sets. By manipulating whether the point values or likelihood of the items appearing on the test favored easy (concrete or semantically related) or difficult (abstract or semantically unrelated) items, Ariel et al. juxtaposed the dominant DRM and RPL models. These models indicate that item selection is based on item difficulty, whereas

the ABR model argues that participants' agendas may cause them to base selection decisions on something other than item difficulty. Consistent with these possibilities, Ariel et al. demonstrated that younger adults selected items for restudy that were worth more points (or items that were more likely to appear on an upcoming test), regardless of item difficulty.

The present work expands on the Ariel et al. (in press) research with younger adults to demonstrate that older adults may also select and allocate study time based more on an agenda (e.g., avoid more difficult items regardless of their point value or experimenter-determined goals) than on item difficulty or even the nature of the provided goals. For example, in both experiments, older adults with lower vocabularies and WMC were more likely to select and restudy easy items, whereas older adults with lower memory self-efficacy avoided difficult items. Such effects were evident even in Experiment 2, where participants were encouraged to select difficult items by making those items worth more points. In this case, older adults' cognitive ability and memory self-efficacy may influence the development of an agenda that determines how they regulate their study.

Younger and older adults in both experiments were more likely to base their selections on normative than subjective item difficulty, which may have occurred because the grids provided normative difficulty information. However, EOLs were highly correlated with normative difficulty in both groups, suggesting this information would be available, to a great degree, had the grids not included normative difficulty information. Given the fact that both age groups used the normative information, and that the small trends for age differences in EOL accuracy were not statistically reliable, the age differences that did emerge in self-regulated study cannot be attributed to age differences in assessing item difficulty. Participants' allocated study time was consistent with the RPL prediction, in that individuals allocated time to items they judged as most easy to learn given their preexisting knowledge levels, goals and time constraints. Across both experiments, older adults focused more time on easier items than did younger adults, and younger adults given less time prioritized studying medium items relative to younger adults given more time, who spent more time on the most difficult items.

Although younger adults given more study time allocated similar amounts of time to moderately difficult and difficult items, neither older nor younger adults' recall benefited from this additional time. It remains possible that the additional study time failed to benefit recall of more difficult items because participants' perceived rates of learning caused them to cease studying items before they achieved additional learning gains (Metcalfe & Kornell, 2005). Because participants were asked to study all 72 items without receiving any indication about whether their perceptions of learning were correct (e.g., either in the form of an intervening recall test or explicit feedback about recall performance), it may have been difficult for participants to gauge whether they should allocate time differently. It remains an open question as to whether individuals opted to not use all their study time because they erroneously believed they had fully learned items or because they were eager to quickly reach the recall test in an attempt to minimize forgetting.

Performance feedback may have allowed participants to realize that using more of their allotted study time would boost their recall performance. The work by Castel et al. (2002) suggests that feedback may be necessary for older adults to maximize performance. Older adults in the Castel et al. study did learn to focus on high-value items, but Castel et al. provided multiple study-test trials, with performance feedback after each recall session. Thus, future research should examine how performance feedback, either alone or in combination with an enforced minimum self-regulated study time, affects younger and older adults' ability to self-regulate their study when learning foreign language vocabulary pairs.

In addition, future research should evaluate how manipulating word and point goals separately, rather than jointly in a potentially competing fashion (e.g., high word and low point), impacts self-regulation and recall. The changes observed in older adults' selections across experiments are consistent with the notion that the complexity of the goals and points in Experiment 2 may have taxed older adults' ability to effectively pursue the experimenter-provided goals, or alternatively, their own agendas for learning via ABR. Ariel et al. (in press) noted that because agenda execution (or pursuit of experimenter-determined goals) is a top-down process requiring cognitive resources, any manipulations that tax these resources will prove detrimental to agenda regulation. Consistent with their hypothesis, Ariel et al. (Experiment 4) demonstrated that reward and point value manipulations had a diminishing influence on younger adults' selections when they were placed under conditions that taxed cognitive resources (i.e., selecting items under sequential rather than simultaneous format; see Thiede & Dunlosky, 1999). Thus, providing goals and point values may have negatively affected older adults' ability to control their selection and study time allocation behaviors, leading many of them to adopt a cognitively less challenging "study easy items" agenda as opposed to effectively pursuing the experimenter-determined goals. Ariel et al. concluded that ABR can account for cases where individuals' item selection and study time allocation behaviors do not seem to be based on item difficulty or other seemingly salient manipulations (e.g., goals or point values), but even ABR deteriorates when individuals are placed in conditions that are cognitively overwhelming.

In keeping with the idea that factors other than item difficulty may influence selection and study time allocation decisions, Castel (2007) suggested that objective or subjective perceptions of value can influence which items younger and older adults attend to and later recall. Castel further proposed that older adults may have greater difficulty than younger adults restricting their focus to higher valued items. This could account for older adults' tendency to study more items than did younger adults in the present research, but achieve lower recall performance and fewer points. The Ariel et al. (in press) ABR model and Castel's (2007) value-directed remembering perspective converge to suggest that individuals will selectively focus on items deemed valuable (e.g., in terms of one's agenda), whether subjective value coincides with experimenter-provided goals and point values or not.

Future research should also examine additional boundary conditions under which RPL-consistent effects are more or less likely to be found. For instance, if more study-test trials were provided, would older adults hit the functional ceiling of their RPL and continue to avoid difficult items? Work by West and colleagues suggests that if older adults experience failure in achieving goals, they will limit opportunities for further learning by maintaining low performance goals (West et al., 2003). By contrast, training that provides mastery experiences and restructures negative self-efficacy beliefs can lead to more optimal learning (West, Bagwell, & Dark-Freudeman, 2008). It is an open question, then, whether older adults' limited performance goals and negative memory self-efficacy would translate into producing a functional limit on RPL, capping learning at a lower asymptote, absent interventions such as implemented by West et al. (2008).

The present experiments have provided an initial basis for examining the constraints that task manipulations (e.g., points and goals) might have on the likelihood of RPL model predictions holding, given the finding that selection order and the difficulty level of participants' initial selections was somewhat malleable to points and goals. Now that there is evidence that older adults initially select items in a RPL-consistent fashion when the standard Metcalfe and Kornell (2005) presentation method is used, it opens the door to examine whether other task manipulations influence younger and older adults' self-regulated learning behaviors in similar ways.

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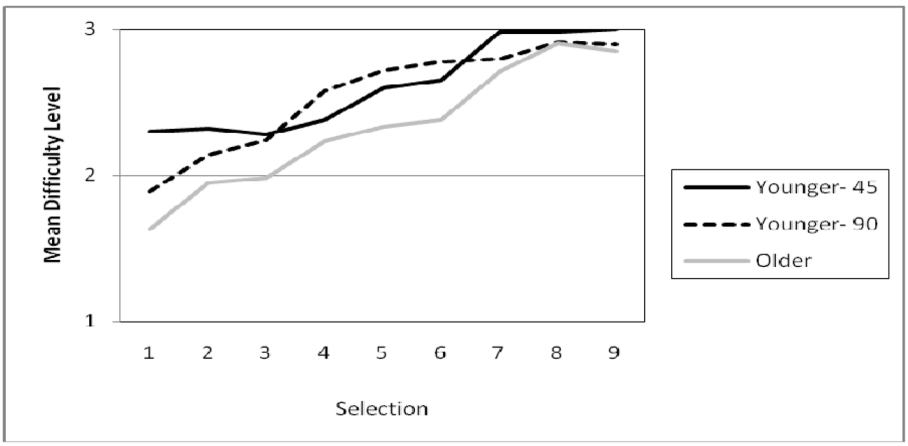

Figure 1.
Mean difficulty level of younger and older adults' first 9 selections in Experiment 1.

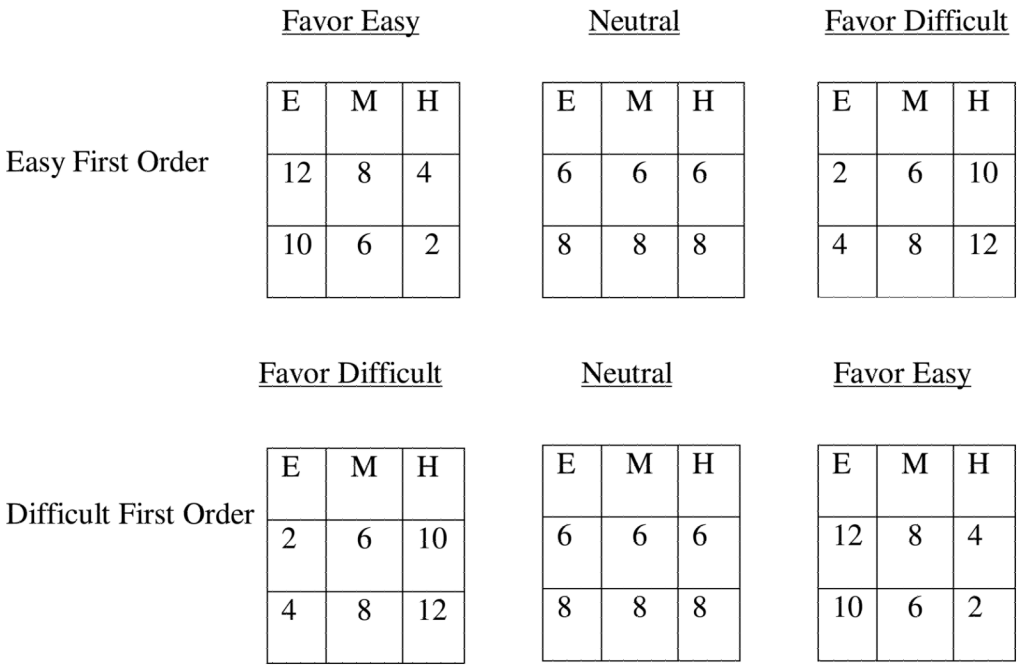

Figure 2.

Graphical depiction of the point order manipulation in which the Easy First order initially favors recall of Easy items and the Difficult First order initially favors recall of the most difficult items.

Note. Within each grid E= easy items, M= medium items, and H= difficult items; Easy First Order = the first of the three grids that participants saw for each of the four goals had points that favored recall of easy items, the second grid was neutral, and the final grid had points that favored recall of difficult items; Difficult First Order = the first of the three grids that participants saw for each of the four goals had points that favored recall of difficult items, the second grid was neutral, and the final grid had points that favored recall of the easy items.

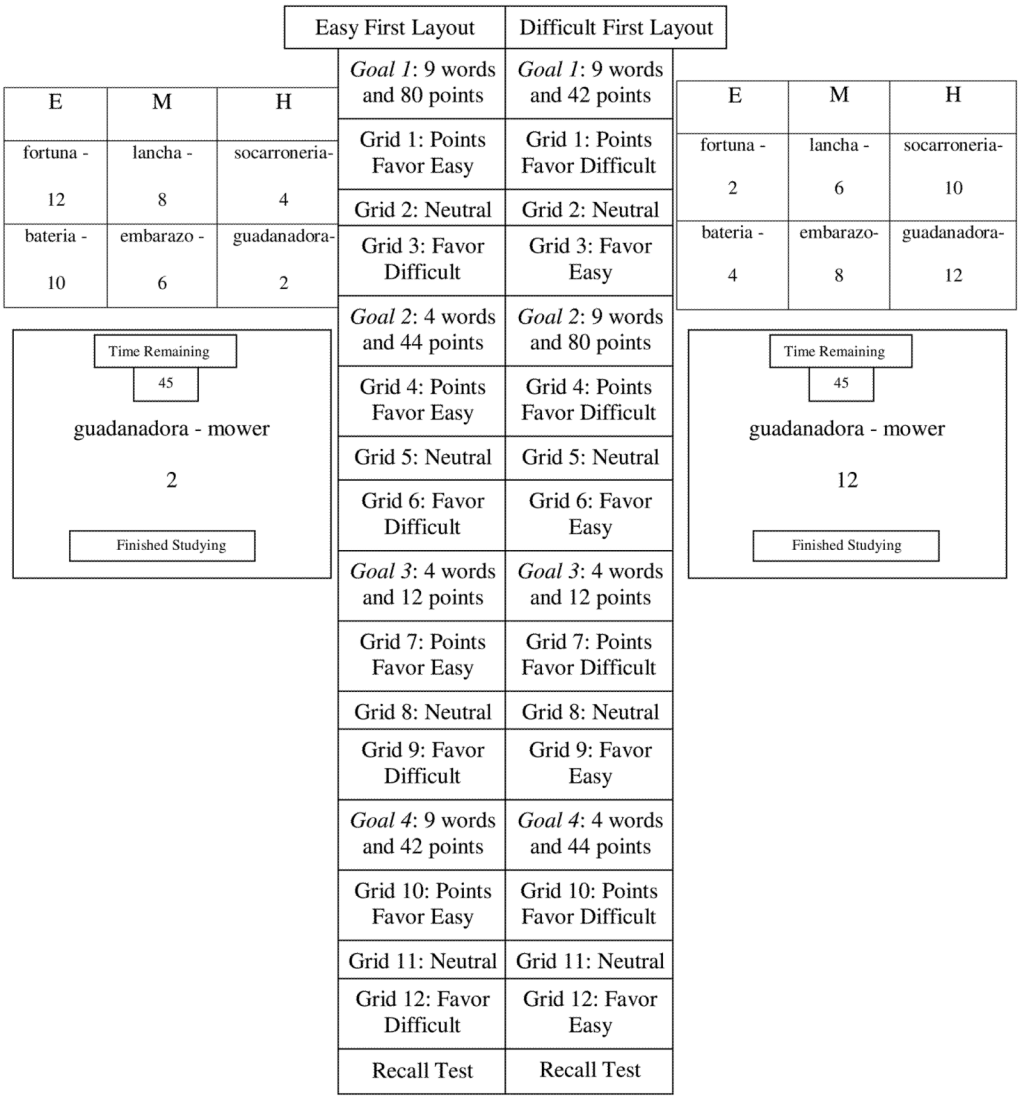

Figure 3.
Layout of grids in the Easy First and Difficult First order conditions.

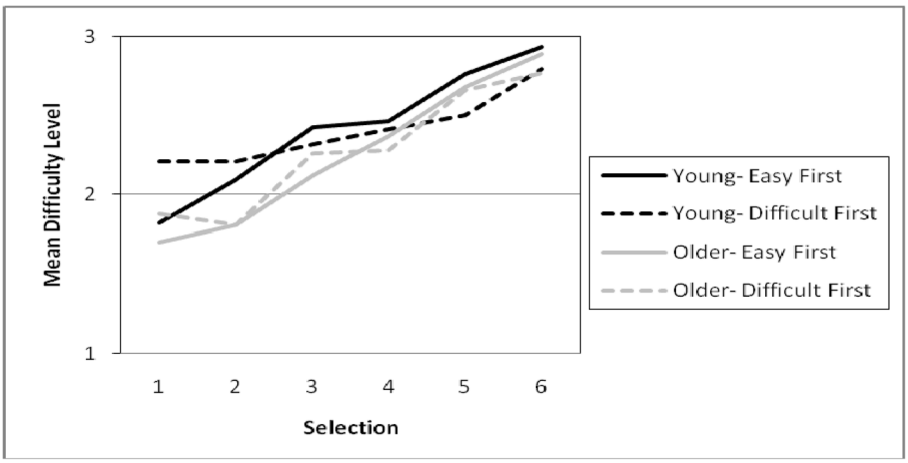

Figure 4.
Mean difficulty level of younger and older adults' first 6 selections in Experiment 2.

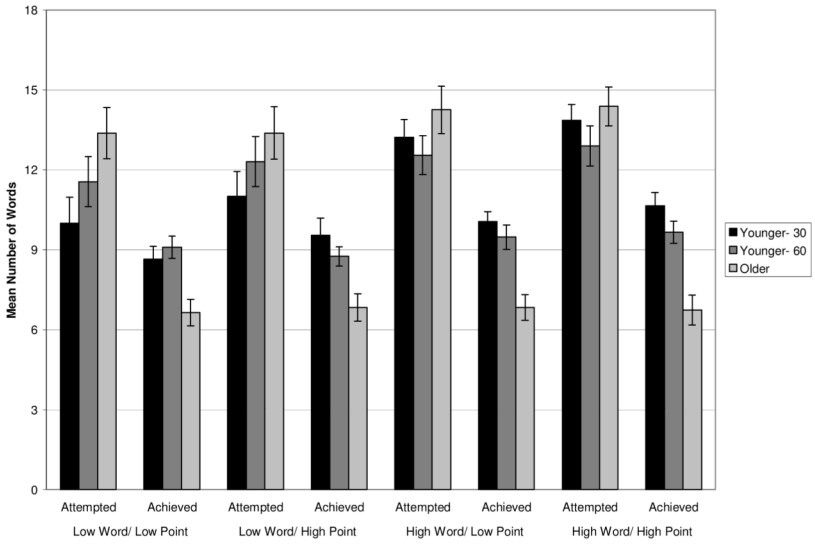

Figure 5.
Experiment 2 Mean Number of Words Attempted and Achieved for each of the Four Experimenter-Determined Goals.

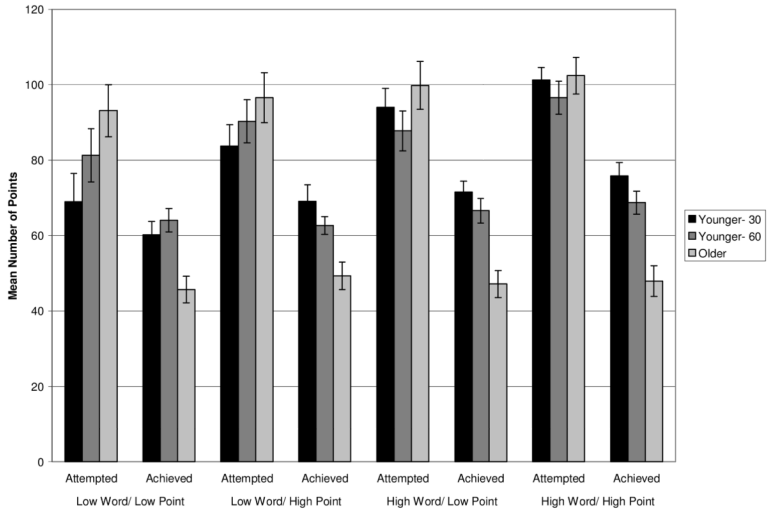

Figure 6.
Experiment 2 Mean Number of Points Attempted and Achieved for each of the Four Experimenter-Determined Goals.

Table 1

Mean Percentage of Participants Who Reselected Items Multiple Times.

	Easy			Medium			Difficult		
Times Reselected	**2**	**3**	**4**	**2**	**3**	**4**	**2**	**3**	**4**
				Experiment 1					
Younger – 45	3	0	0	47	0	0	50	0	0
Younger – 90	3	0	0	63	0	0	72	3	0
Older - 90	29	7	3	77	0	0	71	32	7
				Experiment 2					
Younger – 30	3	0	0	68	16	0	64	13	7
Younger – 60	10	0	0	62	14	3	55	14	0
Older - 60	32	7	0	61	29	10	58	32	13

Note. Entries are the mean percentage of participants who reselected items for study more than once; 2 = items were reselected twice; 3 = items were reselected three times; 4= items were reselected four times; Younger-45 = younger adults in the 45 s group in Experiment 1; Younger-90= younger adults in the 90 s group in Experiment 1; Older-90= older adults in Experiment 1 received 90 s to study items; Younger-30 = younger adults in the 30 s group in Experiment 2; Younger-60= younger adults in the 60 s group in Experiment 2; Older-60= older adults in Experiment 2 received 60 s to study items; Easy = normatively easy items; Medium = normatively moderately difficult items; Difficult = normatively difficult items.

Table 2

Mean EOLs.

	Global EOL	EOL Easy	EOL Medium	EOL Difficult
Age Group	***M (SE)***	***M (SE)***	***M (SE)***	***M (SE)***
		Experiment 1		
Younger – 45	4.62 (.16)	2.46 (.17)	4.60 (.20)	6.79 (.18)
Younger – 90	4.38 (.15)	2.15 (.14)	4.37 (.19)	6.61 (.17)
Older - 90	5.48 (.18)	3.53 (.21)	5.45 (.22)	7.45 (.18)
		Experiment 2		
Younger – 30	4.52 (.14)	2.23 (.16)	4.44 (.18)	6.91 (.17)
Younger – 60	4.58 (.18)	2.61 (.30)	4.49 (.22)	6.65 (.21)
Older - 60	5.76 (.18)	3.86 (.30)	5.83 (.21)	7.58 (.20)

Note. Entries are individuals' mean EOLs (and standard errors); Younger-45 = younger adults in the 45 s group in Experiment 1; Younger-90= younger adults in the 90 s group in Experiment 1; Older-90= older adults in Experiment 1 received 90 s to study items; Younger-30 = younger adults in the 30 s group in Experiment 2; Younger-60= younger adults in the 60 s group in Experiment 2; Older-60= older adults in Experiment 2 received 60 s to study items; Global = mean EOL for all items, ignoring difficulty level; Easy = normatively easy items; Medium = normatively moderately difficult items; Difficult = normatively difficult items.

Table 3

Experiment 1 Mean EOLs for Non-selected and Selected Items.

	Non-Selected	Selected
EOL Type	***M (SE)***	***M (SE)***
Younger Adults – 45		
Easy Items	2.28 (.06)	3.71 (.21)
Medium Items	4.67 (.35)	4.60 (.07)
Difficult Items	7.01 (.15)	6.77 (.07)
Younger Adults – 90		
Easy Items	2.09 (.06)	2.81 (.23)
Medium Items	4.55 (.20)	4.33 (.08)
Difficult Items	6.63 (.17)	6.60 (.07)
Older Adults		
Easy Items	3.51 (.09)	6.20 (.74)
Medium Items	5.41 (.09)	6.39 (.32)
Difficult Items	7.44 (.06)	7.71 (.10)

Note. Entries are means (and standard errors) of individuals' ease-of-learning (EOL) judgments (corrected for pre-study recall test performance) as a function of whether items were selected for study or not. EOL = ease of learning judgment; easy = normatively easy items; medium = normatively moderately difficult items; difficult= normatively difficult items.

Table 4

Proportion of Study Time Allocated to Items.

	Easy	Medium	Difficult
Age Group	***M (SE)***	***M (SE)***	***M (SE)***
	Experiment 1		
Younger – 45	.02 (.01)	.42 (.02)	.56 (.02)
Younger – 90	.01 (.01)	.36 (.01)	.63 (.01)
Older -- 90	.06 (.01)	.47 (.03)	.47 (.04)
	Experiment 2		
Younger – 30	.05 (.01)	.41 (.02)	.53 (.03)
Younger – 60	.06 (.01)	.42 (.02)	.53 (.02)
Older -- 60	.13 (.02)	.46 (.02)	.41 (.03)

Note. Entries are means (and standard errors) of individuals' proportion of time allocated to easy, medium, and difficult items; these values were calculated by dividing the time allocated to items within each difficulty level by the total time spent studying all items; Younger-45 = younger adults in the 45 s group; Younger-90= younger adults in the 90 s group; Older-90 = older adults given 90 s; Younger-30 = younger adults in the 30 s group in Experiment 2; Younger-60= younger adults in the 60 s group in Experiment 2; Older-60= older adults in Experiment 2 received 60 s to study items; Easy = normatively easy items; Medium = normatively moderately difficult items; Difficult = normatively difficult items.

Table 5

Experiment 1 Pre-study and Post-study Recall Test Performance.

	Younger- 45	Younger- 90	Older
Test/Level	***M (SE)***	***M (SE)***	***M (SE)***
Prestudy Test			
Easy	.85 (.02)	.88 (.01)	.71 (.04)
Medium	.02 (.01)	.04 (.01)	.03 (.01)
Difficult	0	0	0
Poststudy Test			
Easy	.97 (.01)	.98 (.01)	.88 (.02)
Medium	.64 (.04)	.72 (.03)	.39 (.05)
Difficult	.27 (.04)	.33 (.04)	.09 (.02)

Note. Entries are means (and standard errors) of individuals' pre-study and post-study recall test performance; Younger-45 = younger adults in the 45 s group; Younger-90= younger adults in the 90 s group; Easy = normatively easy items; Medium = normatively moderately difficult items; Difficult = normatively difficult items.

Table 6

Experiment 2 Mean EOLs for Non-selected and Selected Items.

	Non-Selected	Selected
EOL Type	***M (SE)***	***M (SE)***
Younger Adults – 30		
Easy Items	2.89 (.38)	3.59 (.37)
Medium Items	4.63 (.21)	4.32 (.20)
Difficult Items	7.04 (.15)	6.81 (.17)
Younger Adults – 60		
Easy Items	3.07 (.55)	3.93 (.49)
Medium Items	4.51 (.30)	4.50 (.24)
Difficult Items	6.61 (.29)	6.65 (.19)
Older Adults		
Easy Items	4.12 (.40)	4.86 (.29)
Medium Items	5.89 (.31)	5.79 (.23)
Difficult Items	7.95 (.25)	7.53 (.20)

Note. Values represent mean EOL ratings (corrected for pre-study recall test performance) for items that were or were not selected as a function of difficulty level. Easy = normatively easy items; Medium = moderately difficult; Difficult = normatively difficult items.

Table 7

Mean EOLs for Non-selected and Selected Items as Function of Goal Demands

	Non-Selected	Selected
Goal (Word/Point)	***M (SE)***	***M (SE)***
Younger Adults		
Low/Low (4/12)	6.06 (.13)	5.18 (.10)
High/Low (9/42)	6.23 (.16)	5.24 (.09)
Low/High (4/44)	5.82 (.14)	5.35 (.10)
High/High (9/40)	6.31 (.17)	5.36 (.09)
Older Adults		
Low/Low (4/12)	6.81 (.21)	6.30 (.14)
High/Low (9/42)	7.31 (.21)	6.07 (.12)
Low/High (4/44)	7.27 (.20)	6.36 (.13)
High/High (9/80)	7.45 (.21)	6.26 (.12)

Note. Values represent mean EOL ratings (corrected for pre-study recall performance) for items that were or were not selected from the three grids associated with each of the four experimenter-determined goals. Abbreviations: Low/Low = the low word/low point goal which required recall of 4 words worth at least 12 points; High/Low = high word/low point goal which required recall of at least 9 words worth 42 or more points; Low/High = the low word/high point goal which required 4 words and 44 points; High/High = the high word/high point goal which required 9 words totaling at least 80 points; EOLs were collected on a 1 to 9 scale for which 1 was easy and 9 was difficult.

Table 8

Experiment 2 Pre-study and Post-study Recall Test Performance.

	Younger-30	Younger-60	Older
Test/Level	***M (SE)***	***M (SE)***	***M (SE)***
Pre-study Test			
Easy	.86 (.02)	.87 (.02)	.68 (.04)
Medium	.05 (.01)	.04 (.01)	.02 (.01)
Difficult	0	0	0
Post-study Test			
Easy	.95 (.01)	.97 (.01)	.82 (.03)
Medium	.50 (.04)	.45 (.04)	.27 (.04)
Difficult	.16 (.04)	.12 (.04)	.04 (.01)

Note. Table values are means and standard errors for participants' pre-study and post-study recall performance as a function of difficulty level; Easy = normatively easy items; Medium = normatively moderately difficult items; Difficult = normatively difficulty items; Younger-30= younger adults in the 30 s group; Younger-60= younger adults in the 60 s group.