Published in final edited form as:

Curr Dir Psychol Sci. 2011 June ; 20(3): 167–173. doi:10.1177/0963721411409026.

Metacognition in Later Adulthood: Spared Monitoring Can Benefit Older Adults' Self-regulation

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Abstract

Metacognition includes two key concepts: monitoring of internal states, and adaptive use of control strategies based on that monitoring. We review studies that indicate that aging does not materially affect the accuracy of elementary forms of monitoring encoding and retrieval states in episodic memory tasks, even though it does influence episodic memory itself. Spared monitoring accuracy can therefore serve as a basis for older adults' use of compensatory strategies to achieve learning goals, despite the influence of aging on mechanisms of learning. Metacognitive intervention studies based on this premise show greater effects on learning than traditional strategy-training approaches. Use of strategies for self-regulation, informed by monitoring, may be an important tool for older adults' effective cognitive functioning in everyday life.

Metacognition is defined as thoughts, beliefs, and other cognitive processes devoted to assessing and controlling one's own cognitions. Achieving effective control over cognition often requires active monitoring of current states of the mind to decide whether one is proceeding towards a processing goal. For instance, older adults learning the symptoms of diabetes will need to accurately monitor whether they can retrieve the facts about nutrition and blood glucose monitoring they have been studying so that they can further review the information they cannot access. In this example, monitoring and control are in a reciprocal relation (Nelson & Narens, 1990): monitoring involves the evaluation of information from an on-going cognitive process (such as a retrieval search), whereas control involves the use of that monitoring to make decisions about whether (and how) to change cognitive processing to achieve one's goal (such as restudying what one cannot access). Monitoring and control are viewed as critical components of self-regulation (e.g., Nelson, 1996; Winne & Hadwin, 1998).

Over the last two decades, experimental research on metacognition has flourished (Dunlosky & Metcalfe, 2009), providing new approaches for evaluating monitoring and its use in effectively controlling cognition. These approaches have been used to investigate age-related changes in metacognition across adulthood (e.g., Hertzog & Hulstsch, 2000). A major motivation for these investigations is that any sparing of metacognitive processes in aging may be valuable in helping older adults compensate for typical age-related declines in cognitive performance (for a review of such age deficits, see Salthouse, 2010). For instance, individuals who more accurately monitor their learning (versus those who are less accurate) can more effectively control their learning through selective restudy (e.g., Thiede, 1999). Thus, effective use of metacognitive monitoring could help older adults compensate for

memory declines by means of selective, compensatory study efforts, enabling satisfactory levels of final learning. Inspired by such a rationale, we have systematically investigated (a) whether the constructs of metacognitive monitoring and control are useful in understanding age differences in learning and retrieval and (b) what role metacognition can play in helping older adults compensate for normative age-related declines in learning. This paper sketches some key findings regarding aging and metacognition, with a focus on older adults' monitoring and whether they can use it to improve their self-regulated learning.

Assessment of Metacognitive Monitoring

We first introduce the methods often used to measure metacognitive monitoring and its accuracy. Research on monitoring uses different types of ratings, asking people to judge their confidence in the success of on-going cognitive processes. For example, people may be asked to judge their success in learning new material by reporting their confidence that information they are currently studying will later be remembered. These *judgments of learning* (JOLs) can be made either immediately after a given item is studied (e.g., after studying a paired associate, TICK – SPOON, the individual would immediately judge the likelihood of subsequent recall) or after a delay (for delayed JOLs, an item would be studied followed by the study of other items; after several minutes have passed, the individual is shown the cue – e.g., TICK - ? – and is asked to predict subsequent memory for the response). Immediate JOLs are largely based on how fluently the item being judged had just been processed during study (i.e., higher JOLs when processing is more fluent), whereas delayed JOLs are largely based on the retrieval of responses from long-term memory (i.e., higher JOLs when responses are recalled). Although the later tap retrieval processes, we consider both encoding judgments because they pertain to how well items have been learned during encoding.

To measure retrieval monitoring, people might judge the likelihood that they will recognize an answer to a question that they cannot currently recall. For instance, when they cannot recall the answer to a memory query (e.g., Who wrote the epic novel, *Shogun*?), they would judge the likelihood of correctly recognizing the answer if it were provided. These *feeling-of-knowing* (FOK) judgments are commonly used to measure the degree to which people know whether sought-after information is available in memory, even though it is not currently accessible.

Monitoring, as measured by introspective ratings such as FOKs, is empirically validated against objective measures of the judged processes (Nelson, 1996). For instance, JOLs made while studying paired associates could be compared to later performance on a test of paired-associate recall. FOK judgments are typically validated by performance on a subsequent recognition memory test. Monitoring accuracy is then assessed by computing the correspondence between each person's judgments and criterion performance. Several kinds of accuracy have been examined (see Dunlosky & Metcalfe, 2009), but our chief interest in this review concerns relative accuracy, or resolution. *Resolution* refers to the degree to which the judgments discriminate between items that are correct (vs. incorrect) on the criterion test. If a person judges that one item has been well learned and another has not been, and the former item (and not the latter) is remembered on the criterion test, then judgment resolution for these items is excellent. Resolution is typically computed with a within-person ordinal correlation (Goodman-Kruskal gamma correlations) between the judgments and criterion performance (for alternative measures, see Masson & Rotello, 2009). Correlations greater than zero indicate above-chance resolution, with higher positive correlations indicating better resolution.

Effects of Aging on Monitoring during Encoding

Younger and older adults have above-chance and equivalent resolution of immediate JOLs for paired-associate items (e.g., Hertzog, Kidder, Powell-Moman, & Dunlosky, 2002; Robinson, Hertzog, & Dunlosky, 2006). Delaying JOLs improves their resolution, probably because retrieval from long-term memory is required that simulates (and potentially influences) later recall tests (for a review, see Rhodes & Tauber, 2011). Importantly, delayed JOLs have equivalently high resolution for older and younger adults (e.g., Connor, Dunlosky, & Hertzog, 1997).

These and other studies on aging and JOLs have used extreme age-group designs, in which a group of older adults is compared to a group of college students. This method is limited because (a) it does not provide an estimate of the developmental function (which could be quadratic with a peak in middle age) and (b) using high-functioning college students as the reference group may result in biased estimates of age effects. Accordingly, in a recent study, we extended the evaluation of JOL resolution to include a large cross-sectional sample of adults from ages 18 to 81 (Hertzog, Sinclair, & Dunlosky, 2010). We also experimentally manipulated associative relatedness, including both related (e.g., DOG - CAT) and unrelated (e.g., TICK - SPOON) word pairs. Participants studied each pair and made immediate JOLs, and after this study-judgment phase, they received a test of paired-associate recall. Finally, participants were shown each pair intact, and they were asked to report what strategy (e.g., imagery, sentence generation or repetition), if any, they had used to study each pair.

Figure 1 shows a scatterplot of JOL resolution (i.e., correlations between JOLs and recall) in the aggregate (across all items, shown as black dots) and separately for related (gold dots) and unrelated items (blue dots), along with the best-fitting lines regressing correlations on age in the aggregate (black line) for related item (gold line) and for unrelated items (blue line). No age declines in resolution arose across the adult life-span. In fact, significant age-related increases occurred in the aggregate gamma correlations, as reflected in the positive slope of the black line. This increase is at odds with prior literature using college students as the reference group that demonstrated age invariance in resolution (e.g., Connor et al., 1997). Resolution was also higher in the aggregate, relative to resolution restricted to related or unrelated items, because (1) individuals based their JOLs in part on the cue of associative relatedness, and (2) relatedness is positively associated with PA recall. The age-related increase in aggregate JOL resolution in Figure 1 may not eventually be replicated, but it certainly suggests that aging leaves monitoring of encoding intact.

Other evidence is also consistent with this conclusion. Independent variables that influence immediate JOLs appear to have similar effects for older and younger adults (Hertzog & Hultsch, 2000). For instance, Hertzog et al. (2010) used multilevel modeling to evaluate the joint effects of item relatedness and use of effective encoding strategies on JOLs. People use effective mediational strategies (like interactive imagery) for some items but not for others, and using them improves PA recall (Richardson, 1998). Both relatedness and the use of effective encoding strategies positively influenced JOLs. Most important, age did not interact with relatedness or strategy use in predicting JOLs, indicating no age differences in the use of these two sources of information when making JOLs.

Other studies have also shown that variables about people's encoding predict JOLs for both younger and older adults. For instance, the fluency with which people generate mediators for associative learning is related to JOLs, with faster generation leading to higher JOLs (Hertzog et al., 2003). The magnitude of this fluency effect is similar for older and younger adults' JOLs (Robinson et al., 2006). The similarity of influences on JOLs for people of

different ages, along with equivalent JOL resolution, argues for spared accuracy of monitoring encoding across the adult life span.

We hasten to add that there are circumstances in which older adults have manifested lower JOL resolution. A well-known distinction in recognition memory is between recollection (involving explicit remembering of a former event, including information on perceptual details, encoding context, etc.) and familiarity (recognizing an event as having been previously experienced, without the experience of explicit remembering). Younger adults' recognition memory typically involves a higher proportion of recollected (as opposed to familiar) items, relative to older adults. Daniels, Hertzog, and Toth (2009) studied older adults' JOLs for a word recognition test, in which the response options during the recognition test were recollect (R), familiar (F), and new (N). There were no age differences in JOL resolution when R and F responses were contrasted to N responses, but there were reliable age differences in JOL resolution when R responses were contrasted with pooled F and N responses. This outcome may actually be a consequence of an age deficit in recollection at the time of the recognition test. Older adults produced fewer correct F responses and showed lower discriminability between R and F responses. Older and younger adults may have based their immediate JOLs upon the same kinds of information about encoding processes for the items, but the JOLs may have differed in their predictive validity for R responses because of age-related decreases in the likelihood of strong, valid recollective experiences during the recognition test. This age difference is intriguing, but it does not necessarily detract from the larger message that monitoring of encoding processes is largely spared by aging processes.

Effects of Aging on Monitoring of Retrieval

As discussed earlier, a feeling of knowing is a metacognitive state evoked when information is sought but cannot be recalled. FOKs can be involved in controlling retrieval decisions (Singer & Tiede, 2008); hence age deficits in FOK resolution could contribute to age declines in memory performance. FOK resolution made for general-knowledge information is similar for younger and older adults (e.g., Butterfield, Nelson, & Peck, 1988; Souchay et al., 2007). However, recent work by Souchay and colleagues (e.g., Souchay et al., 2007) argues for a deficit in FOK resolution for information from episodic memory tasks.

We recently tested the hypothesis that age differences in FOK accuracy for episodic memory tasks, when they occur, might be a consequence of the degree of underlying memory quality rather than a deficit in metacognitive monitoring per se (Hertzog, Dunlosky, & Sinclair, 2010). Leading theories argue that two kinds of information can inform FOK judgments (for a review, see Dunlosky & Metcalfe, 2009): (1) the cue for the FOK prompt (e.g., "TICK - ?") activates recognition processes that generate degrees of familiarity, with greater cue familiarity leading to higher FOKs, and (2) the attempt to retrieve the sought-after target – even though it was unsuccessful – can produce other information, with more access to partial information leading to higher FOKs. To the extent that older adults' memory representations are poor in quality, the diagnosticity of cue familiarity or the probability of accessing target-relevant information may be reduced, causing FOKs to have lower resolution.

We presented paired associates once, twice, or four times within a single study period. Because the spaced repetitions (i.e., pairs presented two or four times) would yield high levels of memory performance, we avoided ceiling effects by imposing a multiple-day delay before assessing subsequent recall, FOK judgments, and recognition tests. We used different delays for young and old adults to equate their performance on the recall and recognition tests, testing two groups of older adults with a 30-minute delay and a 48-hour delay, and

younger adults with a 7-day delay. Test performance for the latter two groups was similar, whereas older adults with a 30-minute delay demonstrated the best memory performance.

Repeated presentations influenced memory performance and FOK magnitudes, as expected. It also resulted in higher FOK resolution for both age groups (Figure 2), with a significant Age X Repetition interaction indicating that this benefit was larger for older adults. Most important, FOK resolution on average was at least as good for older adults tested with a 48-hour delay and younger adults.

This experiment supports the hypothesis that the level of underlying memory strength influences FOK accuracy. Thus, although older adults (those given a 30 min. delay) with higher memory performance had better FOK resolution, we do not believe that they have superior monitoring skills. Rather, their superior memory performance, given the shorter delay, produces more information that is diagnostic of test performance, which itself can be exploited to make more accurate FOKs. More generally, rich encoding experiences produce cues that are more diagnostic about the availability of a sought-after target in memory; hence, using these cues will produce more accurate FOKs. One implication is that investigations of age differences in retrieval monitoring should attempt to equate older and younger adults on memory performance to rule out this explanation of age differences in resolution.

Although our focus has been on JOLs and FOK judgments, we would be remiss to not mention that the literature is more mixed regarding whether age differences exist in the accuracy of confidence judgments during recognition memory tests. Retrospective confidence judgments are made after an item has been tested, with people rating their confidence that their recognition response is correct. Older adults are sometimes more likely to produce high-confidence false alarms (e.g., Dodson, Bawa, & Krueger, 2007) and show poorer resolution in confidence judgments when the test situation encourages endorsement of deceptive, incorrect lures (see Kelley & Sahakyan, 2003). The mechanism of these age differences are not entirely understood, but one speculation is consistent with our conclusion about age differences in FOK resolution, as well as the outcomes of the Daniels et al. (2009) JOL study. Namely, older adults often have poorer quality of memories and may have less access to contextual details that would help avoid high-confidence misrecollections.

Do Interventions Training Metacognitive Self-regulation Enhance Older Adults' Learning?

The age-related sparing of metacognitive monitoring is important, because spared monitoring is available as a resource that older adults can use to improve their learning. We have investigated the benefits of training the use of metacognitive monitoring for improving older adults' memory performance. Our first intervention study demonstrated that training metacognitive self-regulation benefits older adults' learning (Dunlosky, Kubat-Silman, & Hertzog, 2003). We trained older individuals (a) to monitor their learning via self-testing (which is akin to making highly accurate delayed JOLs) and (b) then to use this self-testing as a basis for focusing restudy efforts on items that have not yet been learned. This training produced greater performance improvements than more traditional encoding strategy training (see Figure 3) when individuals were allowed to self-pace their study, which affords differential allocation of time and effort to unlearned items. Our self-testing intervention program is also effective when administered using an at-home training manual (Bailey, Dunlosky, & Hertzog, 2010), which broadens the scope of possibilities for delivering this intervention.

One promise of metacognitive interventions is the possibility of broader transfer than training task-specific strategies alone. In principle, metacognitive training could encourage individuals to adapt task strategies to the task environment they encounter. However, Dunlosky et al. (2003) found no transfer of self-testing to a different kind of memory task – free recall of word lists. Given that transfer of training is highly valued (see Lövdén et al., 2010), we have recently begun examining how to promote transfer of metacognitive training to untrained tasks. In some training groups, we explicitly discuss how trained strategies could be used to help trainees perform well on a different task. They do not practice applying the strategy to the new task, but just discuss (with the trainer) how the approach could in principle be used on other tasks. These explicit transfer instructions have an effect. In one study (Cavallini et al., 2010), older adults were trained to use imagery and sentence generation to learn paired associates. Some participants also received transfer instructions in that they discussed how these strategies could be applied to a new task (i.e., learning a grocery list). The transfer instructions resulted in reliable transfer to text learning – a task that they had never practiced nor had been discussed during training. We recently replicated this transfer effect in a new, unpublished experiment.

These outcomes suggest that the lack of transfer in Dunlosky et al. (2003) does not arise from older adults' inability to generalize metacognitive strategies to new task contexts. Instead, older adults may not realize that adapting trained strategies to new contexts requires a process of task evaluation to determine whether and how the self-regulatory strategy can be applied to new materials. Encouraging people to explicitly consider what strategies might be appropriate in a task context may enable them to adapt strategies to fit new task environments. This kind of metacognitive self-regulation training, if properly implemented, may create the desired transfer effects.

In a recent book chapter (Dunlosky, Bailey, & Hertzog, in press), we speculate how these metacognitive approaches can also be combined with simple but effective techniques for enhancing remembering, such as active noticing (intentional allocation of attention), mindfulness, and spaced retrieval, to create habits of engaging the world that may substantially benefit older adults' remembering in everyday life. Our belief is that, in contrast to traditional cognitive training paradigms, metacognitive interventions that enhance self-regulatory awareness and control have great potential for improving older adults' functional competence in cognitively demanding situations.

Acknowledgments

We gratefully acknowledge that this research was supported by a grant from the National Institute on Aging, one of the National Institutes of Health (R37 AG013148). More information on our research program can be obtained at <http://psychology.gatech.edu/CHertzog/>.

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Figure 1.

Cross-sectional regression lines for JOL resolution (gamma) as a function of age for all PA items, related items, and unrelated items (from Hertzog et al., 2010). Copyright: American Psychological Association. Adapted with permission.

Figure 2. Resolution of FOKs with recognition accuracy (gamma correlations) for unrecalled items (from Hertzog et al., 2010). Copyright: Psychonomic Society. Reprinted with Permission.

Figure 3.

Proportion of correct paired-associate recall performance (error bars represent standard errors of the mean) for older adults given self-regulation training (self-testing), traditional encoding-strategy training, or no training (waiting-list control). Adapted from values in Table 1 of Dunlosky et al. (2003).