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BRIEF REPORT

Monitoring One's Own Forgetting in Younger and Older Adults

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The present study examined whether there are age-related differences in the ability to accurately monitor forgetting. Young and older adults studied a mixed list of categorized words, and later recalled items when cued with each category. They then estimated the number of additional items that they did not recall—a form of monitoring one's forgetting. Older adults exhibited impaired memory performance compared with young adults, but also accurately estimated they forgot more information than young adults. Both age groups were fairly accurate in predicting forgetting in terms of resolution, indicating that aging does not impair the ability to monitor forgetting.

Keywords: aging, forgetting, memory, metacognition, metamemory

It is widely documented that older adults' episodic memory is impaired (e.g., Craik & Salthouse, 2008), and that memory failures are one of the most common complaints of older adults (Hertzog & Hultsch, 2000; Levy-Cushman & Abeles, 1998). One's awareness of how memory changes and the ability to monitor changes or declines in memory performance involves metacognition, and the ability to accurately monitor memory (and forgetting) has important theoretical and applied implications. In this study, we examined whether age-related memory impairments are reflected in metacognition, and more specifically, when estimating how much information has been forgotten.

A great deal of research has examined age-related effects on metamemory in terms of monitoring encoding and predicting later recall (using judgments of learning), and these studies have yielded inconsistent results. Some studies examining metacognitive calibration have shown that older adults are often overconfident (i.e., predict they will remember more than they are actually able to) compared with younger adults in predicting later memory performance (Bruce, Coyne, & Botwinick, 1982; Bunnell, Baken, & Richards-Ward, 1999; Connor, Dunlosky, & Hertzog, 1997), whereas other work has shown that older adults are aware of their own memory capacity and, under certain conditions, can accurately predict memory performance (Hertzog, Dunlosky, Powell-Moman, & Kidder, 2002; Hertzog & Hultsch, 2000; Rast & Zimprich, 2009).

Less work, however, has examined how aging may impact the ability to monitor one's own performance on a test *after* taking it, and again results are inconsistent and often differ depending on the actual type of measure used to assess monitoring. Some studies have examined this form of monitoring using postdictive judgments that generally involve asking participants, after a recall test, how many items they think they remembered, given the total number of items presented during encoding (e.g., Bunnell et al., 1999; Hertzog, Saylor, Fleece, & Dixon, 1994). The overwhelming finding from such studies is that there are little to no age-related differences in the ability to accurately monitor performance that has already occurred (Baker, Dunlosky, & Hertzog, 2010; Brigham & Pressley, 1988; Bunnell et al., 1999; Devolder et al., 1990; Hertzog et al., 1994; Hertzog, Sinclair, & Dunlosky, 2010). Thus, older and younger adults are aware of how much they were able to remember under these conditions.

What about metacognitive knowledge regarding what one is not able to recall? Feeling of knowing (FOK) judgments have been used when a person is not able to recall an answer and typically involve asking the person what is the likelihood they would be able to identify the correct response if given a set of choices. Studies examining older and younger adults' FOK accuracy have typically found no age-related differences (Allen-Burge & Storandt, 2000; Butterfield, Nelson, & Peck, 1988; Marquié & Huet, 2000), which further support the notion that monitoring remains relatively intact in old age.

Other studies examining different measures have found age-related impairments in monitoring one's own performance on a memory test. Such results were obtained in experiments that examined output monitoring: When participants were presented with the words they studied and asked to judge whether they had recalled them in a previous recall phase, older adults classified more recalled words as unrecalled than young adults did (e.g., Einstein, McDaniel, Smith, & Shaw, 1998; Koriat, Ben-Zur, & Sheffer, 1988; Marsh, Hicks, Cook, & Mayhorn, 2007). Similarly, studies that examined memory monitoring accuracy at the time of retrieval (i.e., saying if an answer that came to mind has a high or low probability of being correct), have shown age-related impairments (e.g., Kelley & Sahakyan, 2003; Pansky, Goldsmith, Koriat, & Pearlman-Avnion, 2009; Rhodes, & Kelley, 2005).

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The present study examined age-related differences in monitoring memory performance on a test using a novel task that asked people to monitor how much information they had forgotten (Halamish & Koriat, 2010). In many real-life free-recall situations, for example, when we try to draft a mental list that includes errands, assignments, and things to buy in the supermarket, we occasionally feel that we have forgotten some information. It seems likely that what is occurring in such situations is that individuals make spontaneous attempts to monitor forgetting. Yet, the validity of such monitoring, as well as potential age-related differences in monitoring forgetting, has not received experimental attention.

To examine the ability to monitor one's own forgetting, participants were given a list of words from different categories, intermixed. Later, they were given a blocked free-recall test, in which they were cued with category names, one at a time, and were asked to recall the studied exemplars from each category. The number of items from each category was varied within participants, so the number of yet-to-be-recalled items could not be directly inferred from the number of recalled items. Monitoring of forgetting (MOF) was assessed by asking participants to estimate how many additional items they failed to recall from each category.

Several important predictions can be made regarding how younger and older adults may perform when monitoring forgetting. Specifically, older adults may be especially aware of how much information they cannot remember, suggesting intact metacognitive skills regarding the monitoring of what/how much information is forgotten. This may be the result of a great deal of actual experience with forgetting, as well as a strong subjective experience that forgetting occurs more frequently in old age. For example, older adults report a greater frequency of tip-of-the-tongue states (Burke, Mackay, Worthley, & Wade, 1991), which may be especially strong cue regarding the prevalence and frequency of forgetting. Another possibility is that older adults would overestimate their true forgetting, being misled by the availability of forgetting experiences, compared to young adults who may experience less forgetting. Conversely, consistent with other research (Gopie, Craik, & Hasher, in press; Koriat et al., 1988), older adults may have poorer output monitoring skills such that they underestimate how much information has been forgotten, possibly because they do not have access to the products of encoding that then allow for effective monitoring during retrieval.

Method

Participants

The young participants were 20 University of California, Los Angeles, undergraduates who participated for course credit. They averaged 20 years of age and 65% were female. The older participants were 20 individuals recruited from the community, and were given monetary compensation for their time. They averaged 75 years of age and 60% were female. Sixteen of the 20 older participants had completed college, and of those, 11 had completed graduate studies; of the remaining 4 participants, all had completed high school, three had completed some college, and one had completed trade school. The older participants reported that they were in good health.

Materials

Ten exemplars of five categories (vegetables, four-leg animals, musical instruments, clothing, and kitchenware) were chosen from the University of Toronto categorized word pool (Murdock, 1976).

Procedure

Participants were tested individually. In the *study phase* participants memorized a list of 40 words for a later test. The list included 6, 7, 8, 9, or 10 exemplars from each category, with each category size being used once, across the five categories. Specifically, for half of the participants in each age group, the list included 10 animals, 9 vegetables, 8 musical instruments, 7 clothing items, and 6 kitchenware items. For the other participants, the list included 6 animals, 7 vegetables, 8 musical instruments, 9 clothing items, and 10 kitchenware items. Items from the different categories were intermixed in a fixed random order. Participants were not told how many words would be shown, nor were they told beforehand that the words belonged to specific categories. Exemplars were presented on a computer screen for 3 s each with 1 s inter-item interval. Upon completion, participants were asked to say out loud as many U.S. states as they could think of for 30 s as a filler task.

In the *free-recall phase*, participants were presented with the label of each category on the top of a separate blank page, and were asked to recall and write down the studied exemplars that belonged to that category. When done, they were asked to answer the question that appeared at the bottom of the page that asked them to estimate how many additional words from the category they could not remember (i.e., MOF judgment). A note below the question stated that they could respond "0" if they thought they remembered everything. When done, participants went on to the next category on the following page, and this procedure was repeated until participants terminated recall of the fifth category. Participants were given as much time as needed to complete the memory test. Each participant got one of two random orders of categories for recall. Assignment to test order condition was fully crossed with assignment to the two versions of study list, within each age group.

Results

Overall Memory and Metacognition

First, we analyzed memory performance and MOF estimates across categories. For each participant, we summed the number of unrecalled items out of the 40 items studied and the MOF judgments, across the five categories. We focused on forgetting (number of items unrecalled) rather than on remembering (number of items recalled) to make a more direct comparison to the MOF judgments. Results are presented in Figure 1. As the figure suggests, older adults forgot significantly more information than young adults, $t(38) = 2.57$, $p < .05$. On average, older adults failed to recall 18.2 items whereas young adults failed to recall only 13.15 items (i.e., recall rates were 55% and 67% for older and younger adults, respectively).

Consistent with the actual age differences in forgetting, the MOF estimates indicated that older adults estimated they forgot

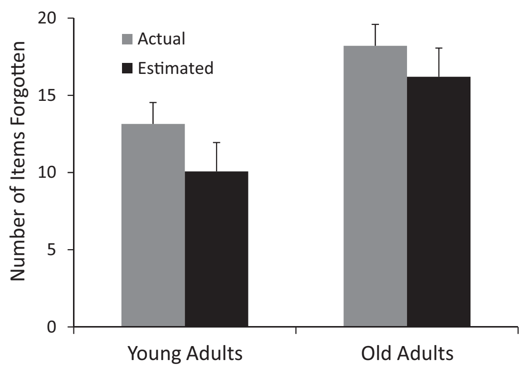

Figure 1. Mean actual and estimated number of forgotten items for younger and older adults. Error bars represent standard error of the mean.

more information than young adults. When summed across the different categories, older adults estimated they forgot 16.20 items, significantly more than young adults who estimated they forgot 10.08 items, $t(38) = 2.33$, $p < .05$. The finding that the age-related differences in the MOF estimates were consistent with the age-related differences in actual memory performance indicates that older adults accurately estimated their increased forgetting. Occasionally, participants provided category exemplars that were not studied and older adults had significantly more intrusions than younger adults (3.00 vs. 0.5), $t(38) = 2.89$, $p < .01$. Across all categories, 17.0% of the responses that older adults provided were intrusions, compared with only 0.2% of the responses of young adults.

Monitoring of Forgetting Calibration

Actual forgetting and estimated forgetting were compared across the different categories in order to examine MOF calibration. As Figure 1 indicates, both age groups estimated that they forgot less information than they actually did. We conducted a 2 × 2 analysis of variance with age group as a between-participants measure (young vs. old) and forgetting (actual vs. estimated) as a within-participants measure. This analysis yielded a main effect of age group, $F(1, 38) = 7.18$, $MSE = 87.01$, $p < .05$, with older adults displaying higher forgetting scores compared with younger adults. The analysis also yielded a main effect of the forgetting measure, $F(1, 38) = 6.17$, $MSE = 20.88$, $p < .05$, which indicated that, across the two age groups, actual forgetting was higher than estimated forgetting. The analysis did not yield a significant interaction, $F < 1$.

However, when we compared actual (memory) and estimated (MOF judgment) forgetting scores for each age group separately, an interesting pattern emerged. For older adults, there was no significant difference between actual and estimated forgetting, $t(19) = 1.14$, *ns*. For young adults, on the other hand, the summed MOF judgments (10.08) were significantly lower than the actual number of unrecalled items (13.15), $t(19) = 2.96$, $p < .01$. Specifically, when these ratios were examined, older adults estimated their forgetting as 92% of their actual forgetting, whereas young adults estimated their forgetting as only 70% of their actual forgetting. Thus, older adults' estimates were somewhat more realistic of actual memory performance than young adults.

Monitoring of Forgetting Resolution

Lastly, we examined MOF resolution—the relative correspondence between estimated and actual forgetting. For the sake of this analysis, we calculated the forgetting rate for each category and participant separately, by dividing the number of unrecalled items by the category size. Following Halamish and Koriat (2010), we pooled the data across all participants and category sizes and then grouped all observations into 10 bins of forgetting rates (0–10%, 11–20%, 21–30% and so on), separately for each age group. For young adults, there were no observations for the two highest bins (81–90%, 91–100%). For older adults, there was no observation for the highest bin (91–100%), and the second-to-high bin (81–90%) was excluded from the analysis for the sake of comparison to the young adults group. Figure 2 presents estimated forgetting (mean MOF judgment) for each forgetting rates bin by age group. Each point in this figure is based on a different number of observations (i.e., combination of participants and categories). The Spearman rank-order correlations ($N = 8$) between actual forgetting rate and MOF was positive and significant for both younger adults, $r_s = .93$, $p < .01$, and older adults, $r_s = .83$, $p < .05$.

We also examined the within-person correlation between actual and estimated forgetting. Pearson correlations between the forgetting rates and MOF judgments[1] were calculated for each participant ($N = 5$ for each correlation).[2] The averaged correlation for young adults ($N = 18$) was .47 ($SD = .44$), and was significantly different from zero by a one-sample t-test, $t(17) = 4.52$, $p < .001$. The averaged correlation for older adults ($N = 19$) was .43 ($SD = .47$), and it was also significantly different from zero by a one-sample t-test, $t(18) = 4.00$, $p < .001$. These correlations were not significantly different between the two age groups, $t(35) = .28$, *ns*. For young adults, the correlations were positive for 16 participants and negative for 2 participants, $p < .01$ by a binomial test. For older adults, the correlations were positive for 15 participants and negative for 4 participants, $p < .05$ by a binomial test. Although these correlations are far from being perfect, they do suggest at least some ability to distinguish situations in which forgetting is high from situations in which forgetting is low, by both young and older adults.

Discussion

Although older adults exhibited impaired memory performance compared with young adults, their MOF judgments suggest that their metacognition is nevertheless intact. That is, older adults remembered less information than young adults and estimated that they forgot more information than young adults. In addition, MOF judgments were fairly accurate for both age groups, in terms of both calibration and resolution. Older adults had a higher frequency of memory intrusions, but were still surprisingly accurate in predicting the number of unrecalled items.

This finding of intact monitoring of forgetting is consistent with the large body of research on postdictive judgments and FOKs,

[1] Analysis of MOF resolution in terms of the relationship between MOF frequency estimates and the *number* of forgotten items (rather than forgetting rates) yielded similar results.

[2] The correlation could not be computed for two young adults and one older adult because of no variability in their MOF judgments.

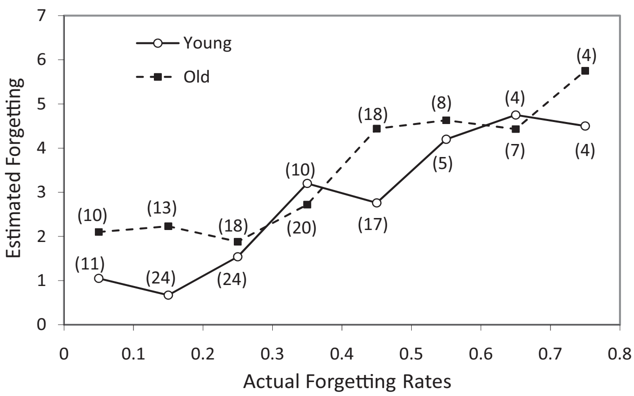

Figure 2. Estimated forgetting (MOF judgments) as a function of actual forgetting rates (grouped into bins) for younger and older adults. Numbers in parentheses represent the number of observations.

suggesting age invariance in the ability to estimate and monitor performance that has already occurred (Baker et al., 2010; Brigham & Pressley, 1988; Bunnell et al., 1999; Hertzog et al., 1994), although somewhat inconsistent with other bodies of research (Gopie et al., in press; Koriat et al., 1988; Souchay, Moulin, Clarys, Taconnat, & Isingrini, 2007). These previous studies had assessed postoutput monitoring judgments by asking participants how much they thought they were able to remember out of *N* number of items (e.g., Hertzog et al, 1994), or asking individuals how confident they were that their responses were correct (e.g., Pansky et al., 2009). In the current study, however, participants were asked to explicitly monitor what they failed to recall rather than what they actually recalled (following Halamish & Koriat, 2010), without being explicitly informed as to the number of items overall or in each category. The fact that the current experiment found comparable results using this different measurement serves to further strengthen the conclusion that, under certain conditions, the ability to accurately monitor one's performance after recall remains largely intact in old age.

What is the basis for participants' explicit estimate of the number of forgotten words? Such judgments could come from one or more possible sources. One possibility is that participants had some sort of direct knowledge about how many words they actually forgot (similar to the direct-access approach, see Nelson, Gerler & Narens, 1984), and had sufficient access to this knowledge to accurately report on their own forgetting. Another possibility, consistent with the cue-utilization framework (Koriat, 1997), is that participants do not have direct access to the forgotten information, but that they use available cues to infer its amount. One possible cue is simply the number of items recalled, which can be used to heuristically assess the number of unrecalled items. Such a cue is valid, as the data suggest that there was a correlation between the number of items provided and the number of items unrecalled (pooled across all participants and category sizes, Pearson correlations were $-.67$ and $-.57$ for young and older adults, respectively, both p's $< .001$; a similar pattern was observed when intraindividual correlations were examined), despite the variation in category size. This explanation requires the assumption that participants can correctly estimate category size (see Hintzman, 1986; 1988), or that they assumed, incorrectly, that all categories had the same size. This possibility cannot be entirely ruled out at the moment. However, two findings from the current study weaken it to some extent. First, if judgments were based on the number of items correctly recalled, the higher rate of intrusion errors by older adults would have likely reduced older adults' MOF accuracy, which was not the case. Second, the lack of relationship between MOF judgments and category size (Pearson correlations of .06 and .03 for young and older adults, respectively, across all categories and subjects; similar pattern for within-person correlations) and the relatively high MOF resolution when examined separately for each category size, for both age groups (ranging between .35 and .78 for young adults, and between .34 and .80 for older adults) suggest that MOF judgments are probably not based solely on category size estimates and the number of recalled items.

Another possibility is that MOF judgments rely on experience-based cues. For example, MOF might be inferred from the level of subtle activation of the unrecalled information. An unrecalled item may produce some degree of activation that is too weak to lead to its explicit recall, but can heuristically and subconsciously be used as a basis for MOF (see Yaniv & Meyer, 1987, for a similar account on FOK). Similarly, MOF might be based on some general representation of earlier encoding operations. For older adults, these representations may be sparse (Koutstaal, 2003) and not allow for veridical recall of specific items that were studied earlier, but older adults can use this more general product of encoding to accurately assess how many items have been forgotten. MOF can also be inferred from the fluency or retrieval ease that is experienced when recalling items from a category, with high fluency eliciting low MOF, and vice versa, similar to situations in which ease of retrieval biases various forms of judgments (see Schwarz et al., 1991).

While the precise mechanism that guides MOF judgments may be based on a number of factors, the finding that older adults can monitor when and how much they are forgetting has important implications. It suggests that, based on their monitoring, older adults would be able to efficiently control how to restudy information (Dunlosky & Hertzog, 1997), or could compensate for their forgetting through the use of memory aids. Furthermore, monitoring of one's forgetting can have implications in everyday activities such as knowing what or how much medication has been forgotten, how many items one may be forgetting when shopping for groceries, or if one has forgotten to pack important items before leaving on a trip. Although the present study examined the ability to monitor forgetting using a retrospective memory task, there may also be important extensions to prospective memory (McDaniel & Einstein, 2000). For example, knowing that you have five items on your "to do" list, but only remembering three, would put you in a position to accurately be aware that you may be forgetting to do something at a later time.

The current study provides an initial step toward the understanding of rememberers' ability to monitor their own forgetting in general, and age differences in this ability in particular. Additional research is needed to examine whether the results presented here generalize to different memory tasks and situations (e.g., longer or shorter lists or retention intervals; a list composed of less distinct categories; estimates of forgetting rates rather than forgetting frequency). The observation that older adults can monitor their forgetting as accurately as young adults suggests that while aging may negatively impact memory performance, monitoring of forgetting is intact. This awareness could then influence the use of effective strategies and control processes (e.g., list making, restudying) in terms of future encoding operations that could serve to enhance memory performance.

References

Allen-Burge, R., & Storandt, M. (2000). Age equivalence in feeling-of-knowing experiences. *Journal of Gerontology: Psychological and Social Sciences, 55B,* P214–P223.

Baker, J., Dunlosky, J., & Hertzog, C. (2010). How accurately can older adults evaluate the quality of their text recall? The effect of providing standards on judgment accuracy. *Applied Cognitive Psychology, 24,* 134. doi:10.1002/acp.1553

Brigham, M. C., & Pressley, M. (1988). Cognitive monitoring and strategy choice in younger and older adults. *Psychology and Aging, 3,* 249–257. doi:10.1037/0882-7974.3.3.249

Bruce, P. R., Coyne, A. C., & Botwinick, J. (1982). Adult age differences in metamemory. *Journal of Gerontology, 37,* 354–357.

Bunnell, J. K., Baken, D. M., & Richards-Ward, L. A. (1999). The effect of age on metamemory for working memory. *New Zealand Journal of Psychology, 28,* 23–29.

Burke, D. M., Mackay, D. G., Worthley, J. S., & Wade, E. (1991). On the tip of the tongue: What causes word finding failures in younger and older adults? *Journal of Memory and Language, 30,* 542–579. doi:10.1016/0749-596X(91)90026-G

Butterfield, E. C., Nelson, T. O., & Peck, V. (1988). Developmental aspects of the feeling of knowing. *Developmental Psychology, 24,* 654–663. doi:10.1037/0012-1649.24.5.654

Connor, L. T., Dunlosky, J., & Hertzog, C. (1997). Age-related differences in absolute but not relative metamemory accuracy. *Psychology and Aging, 12,* 50–71. doi:10.1037/0882-7974.12.1.50

Craik, F. I. M., & Salthouse, T. A. (2008). *Handbook of aging and cognition* (3rd ed.). Mahwah, NJ: Lawrence Erlbaum.

Devolder, P. A., Brigham, M. C., & Pressley, M. (1990). Memory performance awareness in younger and older adults. *Psychology and Aging, 5,* 291–303. doi:10.1037/0882-7974.5.2.291

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

Einstein, G. O., McDaniel, M. A., Smith, R. E., & Shaw, P. (1998). Habitual prospective memory and aging: Remembering intentions and forgetting actions. *Psychological Science, 9,* 284–289. doi:10.1111/1467-9280.00056

Gopie, N., Craik, F. I. M., & Hasher, L. (in press). Destination memory impairment in older people. *Psychology and Aging, 25,* 922–928.

Halamish, V., & Koriat, A. (2010). Monitoring one's own forgetting: A metacognitive perspective on memory search termination decisions. Unpublished manuscript, Department of Psychology, University of Haifa, Haifa, Israel.

Hertzog, C., Dunlosky, J., Powell-Moman, A., & Kidder, D. P. (2002). Aging and monitoring associative learning: Is monitoring accuracy spared or impaired? *Psychology and Aging, 17,* 209–225. doi:10.1037/0882-7974.17.2.209

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

Hertzog, C., Saylor, L. L., Fleece, A. M., & Dixon, R. A. (1994). Metamemory and aging: Relations between predicted, actual and perceived memory task performance. *Aging and Cognition, 1,* 203–237. doi:10.1080/13825589408256577

Hertzog, C., Sinclair, S. M., & Dunlosky, J. (2010). Age differences in the monitoring of learning: Cross-sectional evidence of spared resolution across the adult life span. *Developmental Psychology, 46,* 939–948.

Hintzman, D. L. (1986). Schema abstractions in a multiple-trace memory model. *Psychological Review, 93,* 411–428. doi:10.1037/0033-295X.93.4.411

Hintzman, D. L. (1988). Judgments of frequency and recognition memory in a multiple-trace memory model. *Psychological Review, 95,* 528–551. doi:10.1037/0033-295X.95.4.528

Kelley, C. M., & Sahakyan, L. (2003). Memory, monitoring, and control in the attainment of memory accuracy. *Journal of Memory and Language, 48,* 704–721. doi:10.1016/S0749-596X(02)00504-1

Koriat, A. (1997). Monitoring one's knowledge during study: A cue-utilization approach to judgments of learning. *Journal of Experimental Psychology: General, 126,* 349–370.

Koriat, A., Ben-Zur, H., & Sheffer, D. (1988). Telling the same story twice: Output monitoring and age. *Journal of Memory and Language, 27,* 23–39. doi:10.1016/0749-596X(88)90046-0

Koutstaal, W. (2003). Older adults encode—but do not always use—perceptual details: Intentional versus unintentional effects of detail on memory judgments. *Psychological Science, 14,* 189–193.

Levy-Cushman, J., & Abeles, N. (1998). Memory complaints in the able elderly. *Clinical Gerontologist, 19,* 3–24. doi:10.1300/J018v19n02_02

Marquié, J. C., & Huet, N. (2000). Age differences in feeling-of-knowing and confidence judgments as a function of knowledge domain. *Psychology and Aging, 15,* 451–461. doi:10.1037/0882-7974.15.3.451

Marsh, R. L., Hicks, J. L., Cook, G. I., & Mayhorn, C. B. (2007). Comparing older and younger adults in an event-based prospective memory paradigm containing an output monitoring component. *Aging, Neuropsychology, and Cognition, 14,* 168–188. doi:10.1080/138255891007074

McDaniel, M. A., & Einstein, G. O. (2000). Strategic and automatic processes in prospective memory retrieval: A multiprocess framework. *Applied Cognitive Psychology, 14,* S127–S144. doi:10.1002/acp.775

Murdock, B. B. (1976). Item and order information in short-term serial memory. *Journal of Experimental Psychology: General, 105,* 191–206. doi:10.1037/0096-3445.105.2.191

Nelson, T. O., Gerler, D., & Narens, L. (1984). Accuracy of feeling of knowing judgments for predicting perceptual identification and relearning. *Journal of Experimental Psychology, 113,* 282–300.

Pansky, A., Goldsmith, M., Koriat, A., & Pearlman-Avnion, S. (2009). Memory accuracy in old age: Cognitive, metacognitive, and neurocognitive determinants. *European Journal of Cognitive Psychology, 21,* 303–329. doi:10.1080/09541440802281183

Rast, P., & Zimprich, D. (2009). Age differences in the underconfidence-with-practice effect. *Experimental Aging Research, 35,* 400–431. doi:10.1080/03610730903175782

Rhodes, M. G., & Kelley, C. M. (2005). Executive processes, memory accuracy, and memory monitoring: An aging and individual difference analysis. *Journal of Memory and Language, 52,* 578–594. doi:10.1016/j.jml.2005.01.014

Schwarz, N., Bless, H., Strack, F., Klumpp, G., Rittenauer-Schatka, H., & Simmons, A. (1991). Ease of retrieval as information: Another look at the availability heuristic. *Journal of Personality and Social Psychology, 61,* 195–202. doi:10.1037/0022-3514.61.2.195

Souchay, C., Moulin, C. J. A., Clarys, D., Taconnat, L., & Isingrini, M. (2007). Diminished episodic memory awareness in older adults: Evidence from feeling-of-knowing and recollection. *Consciousness and Cognition: An International Journal, 16,* 769–784. doi:10.1016/j.concog.2006.11.002

Yaniv. I. & Meyer, D. E. (1987). Activation and metacognition of inaccessible stored information: Potential bases for incubation effects in problem solving. *Journal of Experimental Psychology: Learning, Memory and Cognition, 13,* 187–205. doi:10.1037/0278-7393.13.2.187

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