Thirst for knowledge: the effects of curiosity and interest on memory in younger and older adults

Article

Accepted Version

Thirst for Knowledge: The Effects of Curiosity and Interest on Memory in Younger and Older Adults

Shannon McGillivray[1,3], Kou Murayama[2,3,4], and Alan D. Castel[3]

[1]Weber State University, [2]University of Reading, UK, [3]University of California, Los Angeles, [4] Kochi University of Technology

Brief Report

Author Note

Shannon McGillivray, Department of Psychology, Weber State University, Ogden, UT. Kou Murayama, Department of Psychology, University of Reading, Reading, UK and Kochi University of Technology, Japan, and Alan D. Castel, Department of Psychology, University of California, Los Angeles. This research was conducted in partial fulfillment of a doctoral dissertation by Shannon McGillivray at the University of California, Los Angeles. We thank Kevin Pho, Alex Muro, Jenna Joske, and Michael Friedman for help with data collection. Portions of this work were presented at the 14th Biennial Cognitive Aging Conference in Atlanta, GA. This research was supported in part by the National Institutes of Health (National Institute on Aging), Award Number R01AG044335 (Castel), the Marie Curie Career Integration Grant, Award Number CIG630680 (Murayama), and JSPS Kakenhi, Grant Number 15H05401 (Murayama). The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health

Please address all correspondence to Shannon McGillivray, Weber State University, 1299 Edvalson St. Dept. 1202, Ogden UT, 84408-1202, email: smcgillivray@weber.edu

Abstract

Given age-related memory impairments, one's level of curiosity or interest could enhance memory for certain information. In the current study, younger and older adults read trivia questions, rated how curious they were to learn each answer, provided confidence and interest ratings, and judgments of learning (JOL) after learning the answer. No age-related differences in memory were found. Analyses indicated that curiosity and interest contributed to the formation of JOLs. Additionally, interest had a unique increasing relationship with older, but not younger, adults' memory performance after a week. The results suggest that subjective interest may serve to enhance older adults' memory.

Keywords: memory, curiosity, interest, older adults

Word Count: 3,605 (261 lines)

On a daily basis we encounter vast amounts of information, only a small fraction of which we later recall. What causes us to remember some things, and forget others? People often feel that interesting information is better remembered, and the effect of interest on memory has been studied in a variety of contexts, including neuroimaging, reward-based effects, and education (Hidi, 1990; Kang et al., 2009; Murayama & Kuhbandner, 2011; Renninger & Hidi, 2011). While older adults often experience memory impairments (see Craik & Salthouse, 2008), age-related memory differences can be attenuated under certain conditions or when various factors, such as interest, are present (see Zacks & Hasher, 2006). Whether older adults do, in fact, remember information they are more curious about or interested in is a critical issue within the topic of memory and aging (e.g., Meyer, Talbot, Stubblefield, & Poon, 1998; Stine-Morrow, Soederberg, Miller, & Hertzog, 2006), given potential declines in attentional resources and efficient allocation of those resources (Craik & Byrd, 1982). Feelings of curiosity and interest can also be considered positive emotional states, and thus may particularly impact older adults' goal-directed memory processes (Mather & Carstensen, 2005). Affective factors such as interest and curiosity can help direct and sustain attention (Germain & Hess, 2007; Hidi, 1990; Isaacowitz, Wadlinger, Goren, & Wilson, 2006; Mather & Carstensen, 2003; Renninger & Hidi, 2011), and less attentional resources may be needed to process interesting material (McDaniel, Waddill, Finstad, & Bourg, 1990). Interest and curiosity could also guide what older adults attempt to remember, possibly leading to selective remembering of interesting information, at the expense of less interesting materials (see also Castel, 2008).

Prior work has indirectly examined the effects of curiosity and interest on memory in older adults by assessing personal relevance of material. Hess, Rosenberg, and Waters (2001) found that older adults better remembered information related to an older target person

(increased relevance) compared with one describing a younger target person. Germain and Hess (2007) also found increased memory among older adults for age-relevant topics (e.g., anti-aging medications versus tuition increases; see also Hultsch & Dixon, 1983). Furthermore, Stine-Morrow, Shake, Miles, and Noh (2006) found that both younger and older adult readers showed better recall for text that was judged to be more interesting.

The present study examined the effects of initial curiosity and interest on memory for answers to trivia questions. Younger and older adults were presented with a range of trivia questions (the topics were not specifically more relevant to any one age group) and examined memory for the answers to the trivia questions. Importantly, the current study distinguished between the initial level of wanting to know the answer to a question ("initial" curiosity) from the interest in the question and answer once it is known ("post-answer" interest). For example: What product is second, only to oil, in terms of the largest trade volumes in the world? Participants may not feel initial curiosity about wanting to know the answer. Once the answer (coffee) is provided, participants may feel some post-answer interest (e.g., an avid coffee drinker may report higher post-answer interest). These two subjective, affective states are similar, but it is possible that the initial curiosity is dissociated with post-answer interest (e.g., "I was curious about the question, but the answer disappointed or surprised me"). Despite the distinction, no studies have examined their possible differential impacts on memory performance.

Testing younger adults, Kang et al. (2009) found that higher initial curiosity for trivia questions strongly predicted memory accuracy after a week delay (see also Murayama & Kuhbandner, 2011; but note that these studies did not examine post-answer interest). We extended this work by investigating how interest and memory are related in older as well as younger adults. Due to limited cognitive resources, older adults may benefit from curiosity and

interest, because curiosity and interest have inherent properties to direct and sustain attention (Germain & Hess, 2007; Hidi, 1990; Isaacowitz et al., 2006; Mather & Carstensen, 2005; Renninger & Hidi, 2011), facilitating efficient remembering.

We presented younger and older adults with a range of obscure trivia questions (see Appendix), and after being shown each question, participants indicated their curiosity to learn the answer, and their confidence that they knew what the answer was. Confidence ratings were assessed as they could indicate strength of knowledge in the topic area. Furthermore, individuals are also more likely to later recall information following a higher confidence compared with lower confidence error (Butterfield & Metcalfe, 2006). Following these ratings, participants were shown the answer. Expanding on what has been done in prior studies (Kang et al., 2009), post-answer interest was assessed as well as a judgment of learning (JOL) to indicate how well they thought they would be able to later remember that answer. JOLs are often related to memory performance both in younger and older adults (Hertzog & Dunlosky, 2011; Hertzog, Sinclair, & Dunlosky, 2010). As such, we collected JOLs in order to examine whether or not affective variables such as curiosity, confidence, and post-answer interest are integrated into and associated with JOLs. It is important to know if people's general awareness of interest in information is related to retention of the target information, and if affect plays a strong role in metacognitive monitoring, for both younger and older adults. Approximately one hour later, participants were given a cued-recall test on half of the questions and approximately one week later they were tested on the other half, to assess any potential age-related differences in the longer-term retention of this information.

Methods

Participants

The participants were 24 older adults (13 females, *M* age = 72.9, *SD* = 6.1) and 24 younger adults (16 females, *M* age = 20.3, *SD* = 1.2). Older adults were all living in the Los Angeles area, and recruited through community flyer postings as well as through the UCLA Cognition and Aging Laboratory Participant Pool. Older and younger adults had good self-reported health ratings (*M* = 8.2 and 8.8, respectively, on a scale of 1-10 with 1 = extremely poor health and 10 = excellent health). Older adults were paid $10 an hour and reimbursed for parking expenses. Younger adults were all University of California, Los Angeles undergraduates and received course credit and $10 for their participation. Older adults had more years of education (*M* = 17.4, *SD* = 2.7) than the younger adults (*M* =13.9, *SD* = 1.0), who were still enrolled in university. Digit span was not statistically different between age groups, $t(46) = 1.91$, $p > .05$.

Materials

The stimuli consisted of 60 trivia questions, adopted from Kang et al. (2009) and taken from various Internet trivia sites. For example, "What was the first nation to give women the right to vote?" (New Zealand). Appendix A contains a list of the trivia questions and answers.

Procedure

Participants were told that they were going to see 60 obscure trivia questions, and that it was unlikely that they (or most people) would know the answers, although they were encouraged to guess what the answers might be. Participants were asked to indicate which questions they knew the answers to. Trivia questions were presented in one of four fixed-random orders. Participants were not told that they would be tested on the answers, and were simply told the goal was to try to guess the answer, and to make various ratings about the questions and answers.

Participants were presented each question for 10 seconds on a computer. Participants were told to provide a guess if they had one, but were not required to guess. Following the

question, participants provided an initial curiosity rating on a scale from 1-10, (1 = "not curious at all," and 10 = "extremely curious"). Then participants provided a judgment of how confident they were that they knew the answer on a scale from 1-10 (1 = "extremely not confident," and 10 = "extremely confident"). Immediately after these ratings participants were shown the question with the correct answer for 6 seconds. Following the answer, participants rated their interest level in the piece of information now that they knew the answer on a scale from 1-10 (1 = "not interesting at all," and 10 = "extremely interesting"). Lastly, participants indicated how likely they thought it was that they would remember the fact, also on a scale from 1-10 (1= "definitely will not remember," and 10 = "definitely will remember"). Curiosity ratings, confidence ratings, interest ratings, and JOLs were self-paced. The procedure was repeated for all 60 questions. The participant made all ratings and responses verbally which were recorded by an experimenter. Questions participants guessed correctly were noted in order to exclude these from later analyses.

After the trivia question presentation, participants engaged in other unrelated cognitive tasks for approximately 60 minutes (SD = 12.5). Participants were then given a surprise cued recall test on half of the questions (short delay test). Thirty questions were randomly selected and presented in a fixed random order. At test, participants were shown the questions one at a time, and asked to try and recall the answer. Participants were given as much time as needed to answer. If participants indicated they did not know the answer or if they guessed incorrectly, they were told the correct answer. Participants were then contacted again approximately one week later by phone, and were tested on the other half of the questions (long delay test). The assignment of the trivia questions to shorter- and longer-delay conditions were counterbalanced between participants. During the longer-delay test, questions were read aloud to the participant.

Results

In order to only examine new learning, items that participants already knew were excluded from analyses. Older adults knew significantly more answers compared with younger adults (M = 6.5 questions, SD = 3.6 and M = 3.6, SD = 2.6, respectively), $t(46) = 3.15$, $p < .01$. A series of preliminary regression analyses with age group and education level as the independent variables showed that none of the main variables (curiosity, confidence, post-answer interest, JOLs, memory performance at both the short-delay and long-delay, and the initial correct answer to trivia questions) was significantly related to participants' education levels (ps > .05).

Memory Performance as a Function of Delay

To examine cued recall memory performance for the answers to the questions, a mixed 2 (Age Group: younger adults vs. older adults) X 2 (Time Interval: short-delay test vs. long-delay test) Analysis of Variance (ANOVA) was conducted, and revealed neither a significant main effect of age, $F(1, 46) = .02$, $p = .89$, $\eta^2_G = .00$, nor an interaction between Age Group and Time Interval, $F(1, 46) = 2.03$, $p = .16$, $\eta^2_G = .01$. Younger and older adults demonstrated comparable memory performance at both the short-delay test (M = 86.6%, SD = 7.7% and M = 89.1%, SD = 11.9%, respectively) and long-delay tests (M = 51.8%, SD = 12.8% and M = 50.1%, SD = 11.8%, respectively), all p's > .39. A significant main effect of time interval was observed, $F(1, 46) = 620.50$, $p < .01$, $\eta^2_G = .74$, indicating that memory performance declined after the week delay.

Group Differences in Average Ratings

T-tests were conducted to examine whether older or younger adults gave higher or lower average ratings of curiosity, confidence, interest, or JOLs. Older adult had slightly higher average curiosity ratings compared with younger adults (M = 6.5, SD = 1.6 and M = 5.6, SD = 1.4, respectively), $t(46) = 2.28$, $p < .05$, $d = 0.66$, confidence ratings (M = 2.6, SD = 1.3 and M = 1.8, SD = .6, respectively), $t(46) = 2.63$, $p < .05$, $d = 0.76$ and JOLs (M = 6.1, SD = 1.8 and M =

5.0, *SD* = 1.6, respectively), $t(46) = 2.35$, $p < .05$, $d = 0.68$. Older adults also had higher post-answer interest ratings compared with younger adults, although the difference was only marginally significant (*M* = 5.8, *SD* = 1.8 and *M* = 5.0, *SD* = 1.2, respectively), $t(46) = 1.90$, $p = .06$, $d = 0.55$.

Relationships between the Ratings

Correlation matrices for both younger and older adults are displayed in Table 1. The correlation matrices represent within-person correlations; specifically, considering the nested structure of the data (i.e., item-level ratings are nested within participants), we computed item-level correlations after controlling for between person variations based on Kenny and La Voie (1985). All of the self-reported ratings were positively correlated, indicating that curiosity, confidence, post-answer interest, and JOLs have some shared variance. Memory accuracy was also significantly correlated with most of these self-reported indices. The overall pattern of the correlations was similar across the age groups. We also computed the correlation between memory performance and ratings at between-person level (i.e., correlation of mean ratings/performance of individuals). None of the correlations were statistically significant for either age group (*p's* > .15). Memory at short delay and long delay was positively correlated for both younger ($r = 67$, $p < .01$) and older ($r = .58$, $p < .01$) adults.

Mixed-effects Modeling Analyses – Curiosity, Confidence, Interest, JOLs and Memory

To further examine the within-person relations between curiosity, confidence, post-answer interest, JOL, and memory, we conducted mixed-effects modeling analysis using trials as the unit of analysis (Baayen, Davidson, & Bates, 2008; Murayama, Sakaki, Yan, & Smith, 2014; for recent applications in aging research, see Castel et al., 2013; Hines, Touron, & Hertzog, 2009). This analysis allows for the assessment of the independent predictive effects of each of

the variables on the dependent variable at a within-person level -- this point is especially important given that all the ratings were positively correlated.

We first examined the extent to which curiosity and post-interest contributed to participants' JOLs. For that purpose, we tested a mixed-effects model with (trial-level) JOLs as the dependent variable and (trial-level) ratings of curiosity, confidence, and post-answer interest as joint predictors. Both random participant and items effects were modeled (Murayama et al., 2014). All the predictors were treated as fixed-effects and centered within persons (Raudenbush & Bryk, 2002). The analyses were run separately for younger and older adults. As indicated in Table 2, the results showed that curiosity, confidence, and post-answer interest all predicted JOLs in both younger and older adults, although post-answer interest showed the largest effects. To directly examine possible age difference, we also tested a series of models (with both younger and older adults combined) which included the interaction between age and each of the ratings. None of the interaction effects were significant.

We then tested the same mixed-effects model with (trial-level) memory performance as the dependent variable. We used the logit link function to appropriately model the dichotomous dependent variable (i.e., 1 = recalled, 0 = not recalled). In this model, the interpretation is typically made on the exponential of the coefficient, Exp (B), which represents the odds ratio (OR) of recalling an item for a one unit increase in the predictor variable (see Murayama et al., 2014).. The analyses were run separately for younger and older adults, and for both the short and long-delay memory tests. The results (Table 2) showed that only post-answer interest was a significant predictor of memory performance at both the short delay for younger adults, OR = 1.27, $p < .01$, and older adults, OR = 1.22, $p < .05$, as well as at the long delay, OR = 1.17, $p < .01$, OR = 1.30, $p < .01$, respectively.[1] These findings indicate that memory is mainly

supported by intrinsic post-answer interest induced by trivia questions. Curiosity and confidence did not have independent contributions to memory performance, despite the fact that they did have independent effects on JOLs. An interesting observation is that the effects of post-answer interest on memory decreased from a short-delay to long-delay memory tests for younger adults (OR = 1.27 → 1.17), whereas the same effects increased for older adults (OR = 1.22 → 1.30). In fact, when we tested a model that includes the three way interaction of age group, memory delay, and post-answer interest to directly test age difference, the interaction effect was marginally significant (p = .10). These results suggest that, in comparison to younger adults, the role of post-answer interest in memory for older adults might become more crucial as time elapses.

Discussion

The goal of the current study was to evaluate the extent to which initial curiosity, confidence, and interest influence younger and older adults' metacognitive judgments and memory. We found no age-related difference in memory performance, and analyses showed that curiosity, confidence, and post-answer interest contributed to the formation of JOLs both in younger and older adults. While the affective variables of curiosity and confidence predicted JOLs, they were not predictive of later memory. Post-answer interest supported memory performance for both younger and older adults, extending previous findings that one's interest in the material enhances memory (Germain & Hess, 2007; Hess et al., 2001; Mather & Carstensen, 2005; Stine-Morrow et al., 2006). However, the predictive effects of post-answer interest on memory slightly decreased from the short-delay to long-delay memory test for younger adults, whereas the effects increased for older adults, indicating that the role of post-answer interest in memory for older adults may become more crucial as time elapses. The findings illustrate the key role of several affective variables, such as curiosity and interest, and the potential reward

associated with remembering interesting information at a later time. It also may be that it is a rewarding experience to reflect on and recall interesting or important knowledge-based information one was initially curious about, and this be especially so for older adults, who often display various episodic memory impairments.

These findings indicate that post-answer interest may have a direct impact on memory consolidation for older adults, and could be a result of potential goal-directed memory processes engaged by positive emotional states (Mather & Knight, 2005). In the memory literature, responses on immediate and delayed memory tests are presumed to reflect qualitatively distinct representations, with the former reflecting an initial fragile and unstable trace and the latter reflecting a reorganized representation that is less susceptible to loss (Squire, 1992). Several factors have been proposed that selectively influence memory consolidation (e.g., emotions; see Hamann, 2001), including some that may not become apparent without a longer delay (Spaniol, Schain, Bowen, 2013). The decreasing effects of interest from a short-delay to long-delay memory tests for younger adults, but increasing predictive effects for older adults suggest that the consolidation enhancing role of post-answer interest for older adults may become more crucial as time elapses. Post-answer interest could engage additional elaborative processing, cognitive engagement, and attentional resources (e.g., Hidi, 2001; Mather & Carstensen, 2005), and this may be particularly important for older individuals. It should, however, be noted that this time-dependent effect found in the current study may be due to the fact that memory performance at the short delay was near ceiling for both age groups.

The current study also showed that curiosity and confidence did not predict later memory when post-answer interest was included as a predictor. It should be noted that confidence ratings were typically quite low (median = 1), so the hypercorrection effect would be improbable, and

curiosity and interest were highly correlated. In addition, initial curiosity and confidence were also weaker predictors of JOLs in comparison to post-answer interest. While it is probable that curiosity or confidence are sufficient to engage processes that promote later memory performance (and associated metacognitive judgments), all encoding and metacognitive processes may be taken over or interrupted once an interesting answer is learned. Of course, JOLs were assessed immediately after post-answer interest, and both JOLs and post-answer interest were asked after the answers to trivia questions had been presented. Thus it is likely that participants were actively thinking about their interest when forming their JOLs, which could have contributed to the degree of relatedness.

Importantly, and somewhat surprisingly, no age-related memory differences were observed at either the short-delay or long-delay memory test. While the older adults were relatively high functioning, with greater levels of education and similar performance in digit span relative to the college students, level of education did not influence overall performance. It is possible that the inherently positive and engaging nature of the materials contributed to the comparable memory performance by younger and older adults. It could also be that one's surprise in learning the answer, and selective encoding process facilitated by interest could also influence memory, and this is an avenue for future research. Higgins, Cesario, Hagiwara, Spiegel, and Pittman (2010) indicated that the fit between situational supports and an individual's motivational orientations is a determinant of people's interest in the activity. Increasing personal accountability, or even one's knowledge within the topic area, might be ways to facilitate older adults' interest for a task (Hess, Germain, Swaim, & Osowski, 2009). Future work could incorporate these factors to examine the relationship between curiosity and interest and memory in older adults in broader contexts, and other types of materials.

The present study shows that the ability to recall what one is more interested in remains intact among both younger and older adults, and in fact, one's interest may become even more central to learning and memory during old age. Interest might serve to rally and direct attentional resources or lead one to engage in more elaborative encoding, benefiting memory. This effect of subjective interest is particularly important for older adults given declines within certain cognitive domains. Importantly, a person's interests are often linked with satisfaction in life, and the results of the current study are encouraging for any aging individual in that they demonstrate that the ability to remember what we care about does not fade, and in fact may become stronger.

References

Baayen, R.H., Davidson, D.J. and Bates, D.M. (2008) Mixed-effects modeling with crossed random effects for subjects and items. *Journal of Memory and Language* 59, 390-412. doi:10.1016/j.jml.2007.12.005

Butterfield, B., & Metcalfe, J. (2006). The correction of errors committed with high confidence. *Metacognition and Learning, 1,* 69-84.

Castel, A. D. (2008). The adaptive and strategic use of memory by older adults: Evaluative processing and value-directed remembering. In A. S. Benjamin & B. H. Ross (Eds.), *The psychology of learning and motivation* (Vol. 48, pp. 225-270). London: Academic Press.

Castel, A. D., Murayama, K., Friedman, M. C., McGillivray, S., & Link, I. (2013). Selecting valuable information to remember: Age-related differences and similarities in self-regulated learning. *Psychology and Aging, 28,* 232-242. doi: 10.1037/a0030678

Craik, F. I. M., & Byrd, M. (1982). Aging and cognitive deficits: The role of attentional resources. In F. I. M. Craik & S. E. Trehub (Eds.), *Aging and Cognitive Processes*. New York, NY: Plenum.

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

Germain, C. M., & Hess, T. M. (2007). Motivational influences on controlled processing: Moderating distractibility in older adults. *Aging Neuropsychology and Cognition, 14,* 462-486. doi:10.1080/13825580600611302

Hamann, S. (2001). Cognitive and neural mechanism of emotional memory. *Trends in Cognitive Sciences, 5,* 394-400. doi: 10.1016/S1364-6613(00)01707-1

Hertzog, C., & Dunlosky, J. (2011). Metacognition in later adulthood: Spared monitoring can benefit older adults' self-regulation. *Current Directions in Psychological Science, 20,* 167-173. doi:10.1177/0963721411409026

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. doi:10.1037/a0019812

Hess, T. M., Germain, C. M., Swaim, E. L., & Osowski, N. L. (2009). Aging and selective engagement: The moderating impact of motivation on older adults' resource utilization. *Journal of Gerontology: Psychological Sciences, 64B,* 447-456. doi:10.1093/geronb/gbp020

Hess, T. M., Rosenberg, D. C., & Waters, S. J. (2001). Motivation and representational processes in adulthood: The effects of social accountability and information relevance. *Psychology and Aging, 16,* 629-642. doi: 10.1037//0882-7974.16.4.629

Hidi, S. (1990). Interest and its contribution as a mental resource for learning. *Review of Educational Research, 60,* 549-571. doi: 10.3102/00346543060004549

Hidi, S. (2001). Interest, reading, and learning: Theoretical and practical considerations. *Educational Psychology Review, 13,* 191-209. doi: 10.1023/A:1016667621114

Hidi, S. & Renninger, K. A. (2006). The four-phase model of interest development. *Educational Psychologist, 41,* 111-127. doi: 10.1207/s15326985ep4102_4

Higgins, E. T., Cesario, J., Hagiwara, N., Spiegel, S., & Pittman, T. (2010). Increasing or decreasing interest in activities: the role of regulatory fit. *Journal of Personality and Social Psychology, 98,* 559-572. doi: 10.1037/a0018833

Hines, J. C., Touron, D. R., & Hertzog, C. (2009). Metacognitive influences on study time allocation in an associative recognition task: An analysis of adult age differences. *Psychology and Aging, 24*, 462-475. doi: 10.1037/a0014417

Hultsch, D. F., & Dixon, R. A. (1983). The role of pre-experimental knowledge in text processing in adulthood. *Experimental Aging Research*, *9*, 17-22. doi: 10.1080/03610738308258414

Isaacowitz, D. M., Wadlinger, H. A., Goren, D., & Wilson, H. R. (2006). Selective preference in visual fixation away from negative images in old age? An eye-tracking study. *Psychology and Aging, 21*, 40-48. doi: 10.1037/0882-7974.21.1.40

Kang, M. J., Hsu, M., Krajbich, I. M., Loewenstein, G., McClure, S. M., Wang, J. T., et al. (2009). The wick in the candle of learning: Epistemic curiosity activates reward circuitry and enhances memory. *Psychological Science, 20*, 963-973. doi:10.1111/j.1467-9280.2009.02402.x

Kenny, D. A. & La Voie, L. (1985). Separating individual and group effects. *Journal of Personality and Social Psychology, 48*, 339-348. doi: 10.1037/0022-3514.48.2.339

Mather, M., & Carstensen, L. L. (2003). Aging and attentional biases for emotional faces. *Psychological Science, 14*, 409-415.

Mather, M., & Carstensen, L. L. (2005). Aging and motivated cognition: The positivity effect in attention and memory. *Trends in Cognitive Science, 9*, 496-502. doi: 10.1016/j.tics.2005.08.005

Mather, M., & Knight, M. (2005). Goal-directed memory: The role of cognitive control in older adults' emotional memory. *Psychology and Aging, 20*, 554-570. doi: 10.1037/0882-7974.20.4.554

McDaniel, M. A., Waddill, P. J., Finstad, K., & Bourg, T. (1990). The effects of text-based interest on attention and recall. *Journal of Educational Psychology, 92,* 492-502. doi:10.1037/0022-0663.92.3.492

Meyer, B. J. F., Talbot, A., Stubblefield, R. A., & Poon, L. W. (1998). Interests and strategies of young and old readers differentially interact with characteristics of texts. *Educational Gerontology, 24,* 747-771. doi: 10.1080/0360127980240803

Murayama, K., & Kuhbandner, C. (2011). Money enhances memory consolidation--but only for boring material. *Cognition, 119,* 120-124. doi:10.1016/j.cognition.2011.01.001

Murayama, K., Sakaki, M., Yan, V. X., & Smith, G. M. (2014). Type-1 error inflation in the traditional by-participant analysis to metamemory accuracy: A generalized mixed-effects model perspective. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 40,* 1287-1306. doi: 10.1037/a0036914

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods (second edition)*. Newbury Park, CA: Sage.

Renninger, A., & Hidi, S. (2011). Revisiting the conceptualization, measurement, and generation of interest. *Educational Psychologist, 46,* 168-184. doi: 10.1080/00461520.2011.587723

Spaniol, J., Schain, C., & Bowen, H. J. (2013). Reward-enhanced memory in younger and older adults. *Journals of Gerontology, Series B: Psychological Sciences and Social Sciences, 69,* 730-740. doi:10.1093/geronb/gbt044

Squire, L. R. (1992). Memory and the hippocampus: A synthesis from findings with rats, monkeys, and humans. *Psychological Review, 99,* 195-231. doi: 10.1037/0033-295X.99.2.195

Stine-Morrow, E. A., Shake, M. C., Miles, J. R., & Noh, S. R. (2006). Adult age differences in the effects of goals on self-regulated sentence processing. *Psychology and Aging, 21*, 790-803. doi:10.1037/0882-7974.21.4.790

Stine-Morrow, E. A. L., Soederberg Miller, L. M., & Hertzog, C. (2006). Aging and self-regulated language processing. *Psychological Bulletin, 132*, 582-606. doi:10.1037/0033-2909.132.4.582

Zacks, R. T. & Hasher, L. (2006). Aging and long term memory: Deficits are not inevitable. In E. Bialystok & F. I. M. Craik (Eds.), *Lifespan cognition: Mechanisms of change* (pp162-177). New York, NY: Oxford University Press.

Footnote

[1] For completeness, we tested another mixed-effects model which included all affective variables as well as JOLs as joint predictors of memory performance. The analyses revealed that JOLs were the strongest predictor of memory performance at both the shorter delay for younger adults, OR = 1.60, $p < .01$, and older adults, OR = 1.28, $p < .05$, as well as the longer delay, OR = 1.46, $p < .01$, OR = 1.22, $p < .01$, respectively. Most of the effects of the affective variables were no longer significant after including the JOLs. The only exception was that post-answer interest still significantly predicted longer-delay memory performance for older adults, OR = 1.19, $p < .01$.

Table 1. Correlations between Ratings for Younger and Older Adults.

	1.	2.	3.	4.	5.	6.
1. Initial Curiosity for Question	-	.16**	.60**	.47**	.12**	.21**
2. Confidence	.25**	-	.11**	.22**	.03	.09*
3. Post-answer interest	.63**	.24**	-	.67**	.18**	.24**
4. Judgment of learning	.48**	.24**	.63**	-	.30**	.37**
5. Shorter-delay memory accuracy	.11**	.02	.14**	.19**	-	-
6. Longer-delay memory accuracy	.20**	.11**	.28**	.31**	-	-

Note. Correlations above the diagonal are for younger adults and those below are for older adults. All correlations are within-class level, calculated according to Kenny and La Voie (1985). All correlations marked with * are significant at the $p < .05$ level and ** are significant at the $p < .01$ level. Within-class level correlation between short-delay memory accuracy and long-delay memory accuracy cannot be computed, because we used different items to assess these memory accuracy scores.

Table 2. Parameter Estimates in Mixed-effects Models Predicting Judgments of Learning (JOLs) and Memory Performance from Curiosity, Confidence, and Post-answer Interest.

	Younger adults			Older adults		
	JOLs	Short-delay memory	Long-delay memory	JOLs	Short-delay memory	Long-delay memory
Intercept	5.01**	2.56**	0.11	6.14**	3.06**	0.05
Initial Curiosity for Question	0.08*	-0.02	0.06	0.15**	0.09	0.06
Confidence	0.24**	-0.04	0.11	0.08**	0.00	0.03
Post-answer Interest	0.66**	0.24**	0.16**	0.50**	0.20*	0.26**

Note. Asterisks indicate that the means differ from 0, * $p < .05$, or ** $p < .01$. JOLs = Judgments of learning.

Appendix

Complete list of trivia questions and answers.

Question	Answer
What is the slowest swimming fish in the world?	seahorse
What mammal sleeps the shortest amount each day?	giraffe
What city has the shortest name in the world?	Y (France)
Who was the first person to use the V sign as a victory sign?	Winston Churchill
What is the only planet in our solar system that rotates clockwise?	Venus
What is the only consumable food that won't spoil?	honey
What product is second, only to oil, in terms of the largest trade volumes in the world?	coffee
What is most common first name in the world?	Mohammed
What country has the highest population density?	Monaco
What fish produces more than 200 million eggs at a time?	sunfish
What handicap did Thomas Edison suffer from?	deafness
What snack food can be used as an ingredient in the explosive dynamite?	peanuts
What was the first animated film to be nominated for an Oscar for best picture?	Beauty and the Beast
What Beatles song lasted the longest on the American charts?	Hey Jude
What part of a woman's body were ancient Chinese artists forbidden to paint?	foot
What food will made a drug test show up positive?	poppy seeds
Setting a world record, how many days can a human stay awake?	11
What is the longest common English word without any vowels?	rhythm(s)
There are five halogen elements including Fluorine, Chlorine, Bromine, and Astatine. What is the name of the fifth?	Iodine
What is the name of the island country that lies off the southeast coast of India?	Sri Lanka
What was a gladiator armed with in addition to a dagger and spear?	net
In what country is Angel falls, the tallest waterfall, located?	Venezuela
What is the monetary unit of Korea?	Won
What is the biggest constellation in the sky?	hydra
What is the oldest written code of law in history	Hammurabi's code
What was the first product to have a bar code?	Wrigley's gum
What note do most American car horns beep in?	F
What is the name of the instrument used to measure wind speed?	anemometer
What instrument was invented to sound like a human singing?	violin
What organ of the buffalo did Plains Indians use to make yellow paint?	gallbladder
What city is referred to as the Pittsburgh of the South?	Birmingham, Alabama
What animal's excrements are consumed as a luxury food?	bats
What industry used 20% of China's harvested plants?	medicine
What city has the only drive thru post office in the world	Chicago
What did girls in medieval Spain put in their mouths to avoid unwanted kisses?	toothpicks
Who was the first Christian Emperor of Rome	Constantine
What world capital city has the fewest cinemas in relation to its population?	Cairo, Egypt
The Gold Coast is now known as what country?	Ghana
In parts of India, the older brother must marry first. If he cannot find a wife, what can choose to marry?	a tree
What was the first nation to give women the right to vote?	New Zealand
What is the only country in the world that has a bible on its flag?	Dominican Republic
What trade was Greek philosopher Socrates trained for?	stonecutting
What reptile, according to ancient legend, was able to live in fire?	salamander
What unit of measurement is used for fuel wood?	cord
What is the hardest natural substance known?	diamond
What has the only type of product ever promoted by Elvis Presley in a television commercial?	donuts

Before the barometer, what animal did German meteorologists use to predict air pressure changes?	frog
What was the name of Smokey the Bear's mate?	Goldie
What is the only type of bird that has nostrils at the tip of its beak?	kiwi
What novel contains the longest sentence in literature with 832 words?	Les Miserables
Which scientist was the first to receive the Nobel Prize twice?	Marie Curie
What is the name of scientific scale used for measuring the hardness of rocks?	Moh's scale
What vegetable did ancient Egyptians place in their right hand when taking an oath?	onion
What 17th century artist painted more than 60 self-portraits?	Rembrandt
Which metal is the best conductor of electricity?	silver
What organ destroys old red blood cells?	spleen
What American novel was the first to sell over 1 million copies	Uncle Tom's Cabin
What gas forms almost 80% of Earth's atmosphere	nitrogen
What was Dr. Frankenstein's first name?	Victor
With what product did the term "brand name" originate?	whiskey