Chapter 12
Strategic, Emotional, and Motivational Influences on Metacognition in Older Adulthood

Shannon McGillivray

Abstract While older adulthood is often associated with a decline in cognitive functions, there are numerous studies that suggest that metacognitive functioning remains relatively intact. This disparity between, for example, explicit memory functioning and ones' insight and control over memory among older adults raises some interesting questions. Can older adults use metacognitive strategies to help compensate for declining memory functions? What role do interest, emotions, and knowledge have on metacognitive judgments? The current chapter discusses both intrinsic and extrinsic motivational influences, and the role of strategy, in older adults' metacognitive processes.

Keywords Metacognition · Older adults · Emotion · Strategic control · Motivation

12.1 Introduction

Explicit memory abilities have been shown to decline during normal aging (Craik and Salthouse 2008; Kausler 1994), but a growing body of evidence suggests that metamemory process may remain largely intact (for reviews, see Castel et al. 2016; Hertzog 2016; Hertzog and Dunlosky 2011). Metacognition, or metamemory, simply refers to one's awareness and insight about one's own memory and how it works. Metamemory includes, but is not limited to, beliefs about one's memory skills and task demands, strategies one uses to remember information, insight into memory changes, feelings and emotions about one's memory, and knowledge of memory functioning (Dunlosky and Metcalfe 2009).

Specific metamemory measures typically assess either memory monitoring or control (Nelson and Narens 1990). Metacognitive monitoring involves the assessment of ongoing memory encoding and retrieval processes. Monitoring can be

S. McGillivray (✉)
Department of Psychological Science, Weber State University, Ogden, UT, USA
e-mail: smcgillivray@weber.edu

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assessed by asking participants to explicitly report on their beliefs regarding what information is more memorable, or feelings of confidence that what one remembered was accurate. Metacognitive control, which can be influenced by monitoring (Hertzog and Dunlosky 2011), includes behaviors and actions implemented to achieve desired memory-related goals such as restudying information one feels is less well learned, or utilizing mnemonic strategies to enhance later recall. Beliefs that older and younger adults have about their memory abilities (e.g., belief that one will be able to remember important, interesting information) can influence expectations for memory performance (e.g., this information will be remembered), effort exerted during a memory task (e.g., engagement of more elaborative processing or strategy usage), and thus can influence one's actual performance.

This disparity between impaired explicit memory functioning and relatively intact insight and control over memory among older adults raises some interesting questions. Can older adults use metacognitive strategies to help compensate for declining memory functions? The selective optimization with compensation theory suggests that successful aging is related to the ability to strategically focus limited cognitive resources into areas that yield optimal returns (Baltes and Baltes 1990). Furthermore, it has been suggested that older adults may often be more selective compared with younger adults in how they choose to engage their cognitive resources (Hess 2006). Thus, it could be the case that older adults could use metacognitive insight to selectively control cognitive operations based on their goals, motivation, and the meaningfulness of information. Thus, older adults may be able to compensate for impairments by optimizing performance in specific, goal-related domains (Riediger et al. 2006). The current chapter will examine the role that interest, emotions, motivation, and prior knowledge (which have been shown to reduce or eliminate age-related memory deficits; see Castel 2008; Hess and Emery 2012; McGillivray and Castel 2017; McGillivray et al. 2015) have on metacognitive judgments. The current chapter also discusses both intrinsic and extrinsic motivational influences, and the role of strategy and importance, in older adults' memory and metacognitive processes.

12.2 Strategic Metacognitive Monitoring

The ability to recall information that is more important or valuable is essential to healthy memory functioning, and functioning in everyday life. For example, if older adults are not able to recall as much information as younger adults, but are able to recall the most important information, then perhaps quality of memory functioning remains intact despite deficits in memory quantity. Previous studies have investigated older and younger adults' ability to recall objectively more important information and have no age-related deficits in memory for more valuable information (e.g., Castel et al. 2002), truthful versus false information (Rahhal et al. 2002) or medically important information (May et al. 2005; Middlebrooks et al. 2016).

Taking a closer look at value, Castel and colleagues (Castel et al. 2002) have examined both older and younger adults' ability to remember words paired with varying point values. In this "value-directed remembering" paradigm, participants studied 6 lists of different word-value pairs (e.g., book—12, chair—3) and were told the goal was to maximize their score, which was the sum of the point values associated with remembered words. Thus, there was an external incentive to recall the words paired with higher point values, and some information was more "important" to remember. Although younger adults recalled more words than older adults, recall for the words associated with the highest point values showed no age-related differences. These results suggest that older adults are able to remember high-value information to the same extent as younger adults, although it may be at the expense of lower-value information. Older adults seem to be able to shift attention and strategically recall the high-value information at the expense of lower value information, maximizing memory efficiency (Castel 2008; Castel et al. 2002; Friedman and Castel 2013; Hennesse et al. 2019), although this pattern typically only emerges with task experience. These findings also suggest that metacognition may play an important role in older adults' adoption of effective strategies that lead them to attend to and recall higher value information.

Strategy usage is often a product of goal-directed behavior, an element that is typically examined in metacognitive control studies, but not captured in traditional metacognitive monitoring paradigms. One common measure of metacognitive monitoring is a judgment of learning (JOL). During JOL tasks participants are asked to assign some piece of information a numerical value (e.g., 0–100), and this value indicates how likely they think it is that they will later remember that information. These judgments can then be compared to actual memory performance in order to assess absolute and/or relative accuracy. Absolute accuracy of JOLs is typically measured by calculating the average JOL rating (e.g., 70% if the scale was from 0 to 100%), and comparing it with the average percentage of information recalled (e.g., 40%). Absolute accuracy allows for insight into whether individuals display a general pattern of over-or-under confidence in memory abilities (e.g., if the average JOL was 70, but a person only recalled 40% of the material this would indicate overconfidence). Relative accuracy examines whether the JOLs assigned by an individual can distinguish between what information is later remembered versus forgotten, and higher relative accuracy occurs when higher JOLs are given to information later recalled, and lower JOLs are given to information forgotten at test.

In most JOL tasks, there are no actual consequences or outcomes tied to these predictions. However, in the real world there are often consequences associated with whether or not our monitoring judgments are accurate. For example, if you believe you will remember important health information told to you by your doctor, you may decide you do not need to write it down. However, if you are incorrect in your initial assessment of your ability to remember this information, it could have negative repercussions. In order to examine a more strategic form of metacognitive monitoring, some studies have introduced consequences tied to metacognitive predictions (McGillivray and Castel 2011, 2017).

McGillivray and Castel (2011) used a modified value-directed remembering paradigm in which older and younger adults were asked to "bet" on the likelihood they would recall an item, and there were consequences associated with the accuracy of those bets. Participants were given six different lists of words paired with varying point values and were told the point value indicated how much the word was worth. As participants were shown each word, they had to "bet" (yes or no) which items they thought they would be able to remember. If participants bet on an item, then they received whatever points were associated with that item if they later recalled it, but lost those points if they failed to recall it. Participants were told the goal was to maximize their score, and score was the sum of all of the words bet on and recalled, minus the sum of the words bet on and not recalled. Thus, there were rewards associated with accurately monitoring and predicting which items would be recalled, and penalties if one failed to do so.

McGillivray and Castel (2011) found that both younger and older adults' betting and recall performance were significantly driven by the objective point value associated with the words and strategically bet on and recalled more of the high value relative to the low value items (see Fig. 12.1). In regard to metacognitive accuracy, both younger and older adults were highly overconfident on initial lists (i.e., they bet on more items than they were actually able to recall), but this was reduced with task experience. Overall point scores on each list improved with task experience, and in fact older and younger adults' scores were comparable on later lists, despite the fact that older adults recalled less information overall.

The ability of older adults to achieve scores compared to those of younger adults suggests that older adults were implementing strategies that actually led to the marginally better metacognitive accuracy on the later lists, in order to achieve goal-relevant outcomes.

The findings from McGillivray and Castel (2011) indicate that the introduction of negative consequences may have served to enhance motivation to accurately monitor and update performance expectations with task experience, perhaps even to a larger extent for older adults relative to younger adults. While McGillivray and Castel (2011) explicitly indicated which items were more valuable to recall, more recent studies have utilized a similar "betting" paradigm to examine strategic monitoring when participants were allowed to decide what information was more or less "valuable" (McGillivray and Castel 2017). In doing so, it allowed for an examination of potential age-related differences in internally driven strategic metacognitive monitoring.

McGillivray and Castel (2017) presented older and younger adults with either six lists of unrelated words (Experiment 1), mixed lists of related and unrelated word pairs (Experiment 2), or lists of items related to a particular scenario (Experiment 3; e.g., items one might want to take on a camping trip). As participants saw each item, they assigned it a point value from 0 to 10, and if they later recalled the item, they received whatever points were assigned to it, but lost those points if they failed to recall it. Requiring participants to assign a value is more similar to standard JOL paradigms, and allowed for more direct comparisons with prior metacognitive monitoring and aging research. The "bet" (i.e., point value) assigned in McGillivray

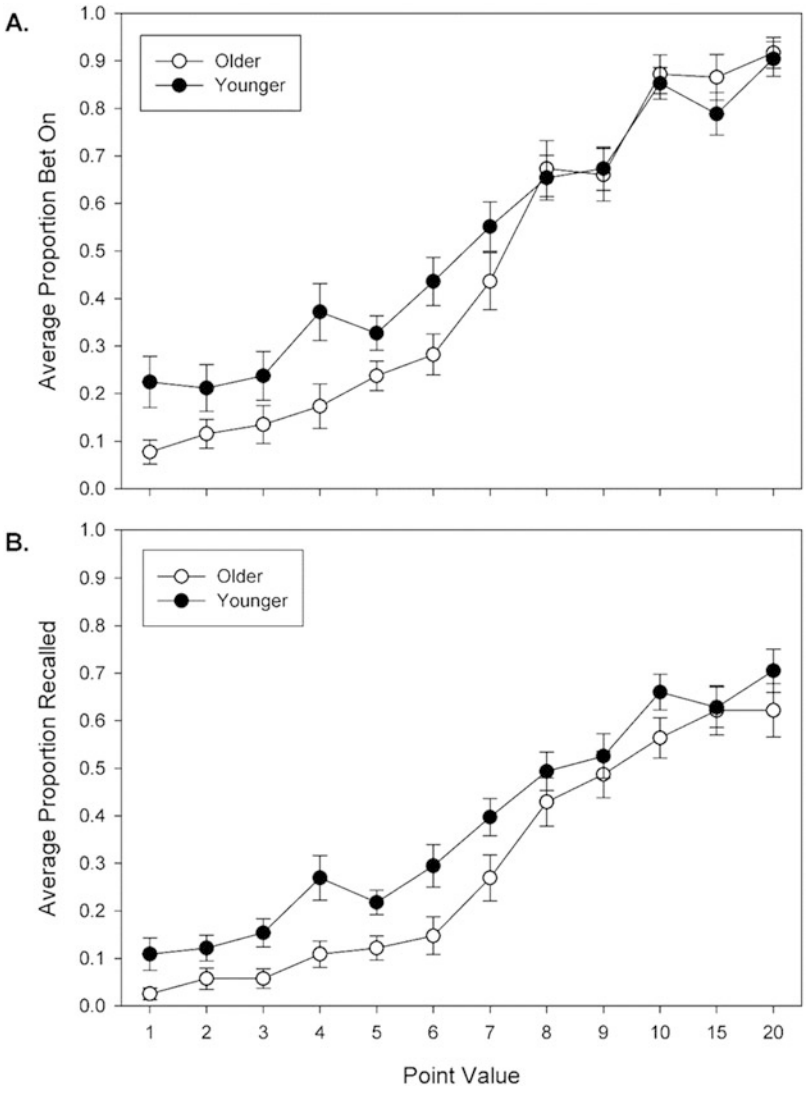

Fig. 12.1 Shows the average proportion of items bet on (top panel A) and recalled (bottom panel B) as a function of point value by older and younger adults. Error bars represent standard error of the mean. Copyright © 2011 by the American Psychological Association. Reproduced with permission. (McGillivray and Castel 2011)

and Castel's (2017) studies is similar to a judgment of how likely a participant believes an item will be recalled. That is, if one thinks an item will be recalled later, a higher value should be given. However, the use of "bets" required one to be strategic, and thus the use of metacognitive control processes during encoding.

McGillivray and Castel (2017) found that when the materials were unrelated single words (Experiment 1) both younger and older adults were able to successfully recall words they had assigned higher subjective values, and were able to improve metacognitive accuracy and reduce initial overconfidence with task experience. When the to-be-learned material were unrelated and related word pairs (Experiment 2), it was found that older adults bet on fewer items, recalled fewer items, and achieved lower point scores compared with younger adults. However, age-related memory differences were eliminated for the related word pairs.

The finding that age-related differences were prominent for the unrelated word pairs is consistent with older adults' deficits in associative learning (Naveh-Benjamin 2000; Naveh-Benjamin et al. 2003; Old and Naveh-Benjamin 2008). However, age-related associative deficits for the related word pairs were not present. It is likely that the related words pairs allowed older individuals to strategically rely on verbal or semantic knowledge, which is less susceptible to age-related declines (McCabe et al. 2010; Naveh-Benjamin et al. 2003). Older adults also displayed better overall metacognitive accuracy than younger adults. This finding of better monitoring abilities in this experiment is somewhat consistent with the finding from Hertzog and colleagues (Hertzog et al. 2002) who have reported that older individuals were more likely to utilize semantic relatedness as a cue when making JOLs. This suggests that older adults may be able to utilize their prior verbal knowledge in an advantageous way when it comes to metacognitive monitoring and optimizing memory-related outcomes.

Experiment 3 (McGillivray and Castel 2017) utilized lists of items that pertained to particular scenarios, such as going on a camping trip. It was found that younger and older adults performed comparable on all of the measures, including overall metacognitive accuracy and recall, although task experience had no impact on performance. In this task, items on each list varied in terms of how central they were to the scenario. For example, on the "camping" list there were, objectively, more important items such as tent and sleeping bag, and also some less important items such as whistle and playing cards. The data suggested that both younger and older adults were able to capitalize on this prior knowledge to effectively assign monitoring judgments, and then later recall the more central information. These findings are consistent with evidence that schemas and prior knowledge (e.g., knowledge of items one might usually take camping) can serve to mitigate typically observed age-related memory deficits (Castel 2005). The results also suggest that when the materials are more realistic, and thus enable one to use prior knowledge, older and younger adults can implement effective strategic learning and monitoring behaviors from the onset.

In regards to strategic metacognitive monitoring abilities of older adults, studies that have implemented consequences associated with monitoring judgments may make individuals feel more accountable for their judgments, which could increase motivation for accuracy and strategy usage. At present, there is growing evidence that the ability to utilize one's metacognitive monitoring (and control) abilities is intact during older adulthood, and that proper motivation and accountability of one's memory predictions can lead one to accurately and strategically monitoring one's

memory processes. This suggests that older adults could effectively utilize metacognitive strategies and awareness to help compensate for age-related changes in memory abilities that in turn can enable older individuals to function successfully in everyday life.

12.3 Strategic Metacognitive Control

Metacognitive control includes behaviors and actions implemented to achieve desired memory-related goals, such as restudying information one feels is less well learned, or utilizing mnemonic strategies to enhance later recall. Metacognitive monitoring and control are thought to have a reciprocal relationship (e.g., Nelson and Narens 1990). Specifically, if one is able to effectively monitor what information is more or less likely to be recalled, then that knowledge can be used to engage strategies to enhance memory for information deemed less well learned. Beliefs that older and younger adults have about their memory abilities (e.g., belief that one will be able to remember important information) can influence expectations for memory performance (e.g., this information will be remembered), effort exerted during a memory task (e.g., engagement of more elaborative processing or strategy usage), and thus can influence one's actual performance. The evidence that older adults can successfully monitor memory operations also suggests that as one ages, intact monitoring abilities could allow one to implement effect control strategies in order to successfully achieve goal-related memory outcomes (Hertzog and Dunlosky 2011).

In regard to age-related changes in metacognitive control, Dunlosky and Connor (1997) observed that when older and younger adults were allowed to restudy words at their own pace, all participants spent more time studying items that they had assigned lower JOLs (i.e., words they judged as more difficult to recall) compared with those words that had been given higher JOLs. However, younger adults exhibited this effect to a greater extent, indicating that some age-related differences were present in the degree to which monitoring was used to effectively allocate study time. Furthermore, Tullis and Benjamin (2012) found that while older adults' study selection choices are similar to younger adults', they may not always lead to optimal memory-related outcomes. That being said, Dunlosky and Hertzog (1997) found that younger and older adults used a "functionally identical algorithm" in their selection of items for restudy, and both younger and older individuals strategically selected items to restudy that they believed were not as well learned (Dunlosky and Hertzog 1997; Hines et al. 2009). While some researchers have observed some age-related deficits in metacognitive control, there are many studies that have found age-related sparing of these processes (for a more comprehensive review of aging a metacognitive control, see Hertzog 2016).

Further evidence of age-related sparing of more *strategic* metacognitive control operations was found by Castel and colleagues (Castel et al. 2013) in a task in which the objective value of the to-be-learned information was varied. The purpose of

using value in this context was to assess the extent to which a salient external cue (i.e., point value) could effectively be used by older and younger adults to guide study choices. In this study, participants were given 2 min to study a list of 30 words, and each word was associated with a different point value (values ranged from 1 to 30). Participants were allowed to study as few or as many of the items as they wanted, they were allowed to study items multiple times, and could control how long they studied each item. Importantly, in this task participants were told the goal was not necessarily to recall as many items as one could, but to obtain a high point score. Scores were the sum of the point values associated with words recalled, and thus some items were more valuable and important to remember. As is shown in Fig. 12.2, both older and younger adults were strategic in terms of studying higher point value words more often, and for longer periods of time, suggesting value or objective importance can be used as a cue to guide strategic and selective metacognitive control behaviors during the learning process.

Examining strategy use further, an important question is how or what do younger and older individuals prioritize during the learning process? Under limited time conditions (as is often the case in experimental studies and in real life), there are a number of different factors that may influence what one chooses to study, such as difficulty level of the material, or importance of the material.

Studies that have manipulated the difficulty of the material have generally found that both younger and older adults tend to study easier items first (Price and Murray 2012), a strategy consistent with the region of proximal learning framework (Kornell and Metcalfe 2006; Metcalfe 2002). The region of proximal learning framework suggests that individuals strategically choose to devote study time to information that one has the greatest likelihood of later remembering. For example, if one had limited time to study, and could either study something very difficult (that might take a while to learn), or something easier (that one had a greater likelihood of mastering), it might be more advantageous to study the somewhat easier information.

While there is evidence that older and younger adults may prioritize easier items first during study processes, how might the importance of the material impact this pattern? If some information is objectively more valuable, but difficult, will individuals selectively focus on this information? Price and colleagues (Price et al. 2010, Experiment 2) presented both younger and older adults with Spanish-English vocabulary word pairs. The vocabulary terms were clearly labeled for participants as being "easy", "medium", or "difficult" to learn, and the point value associated with each term was also manipulated such that for some participants either the easier or harder items were worth more points (there was also a neutral condition in which points were equivalent for all items). In addition, participants were either given a goal of either achieving a higher or lower overall point score. It was found that both younger and older adults still studied easier items first overall, but both age groups were sensitive to point value in their study choices. However, older adults were somewhat less likely than younger adults to study high value, difficult items, and this pattern was related to older adults' memory self-efficacy. These findings indicate that, at times, internal beliefs and knowledge of one's capabilities may influence study choices to a greater extent than do external, goal-relevant cues. Thus, if one believes

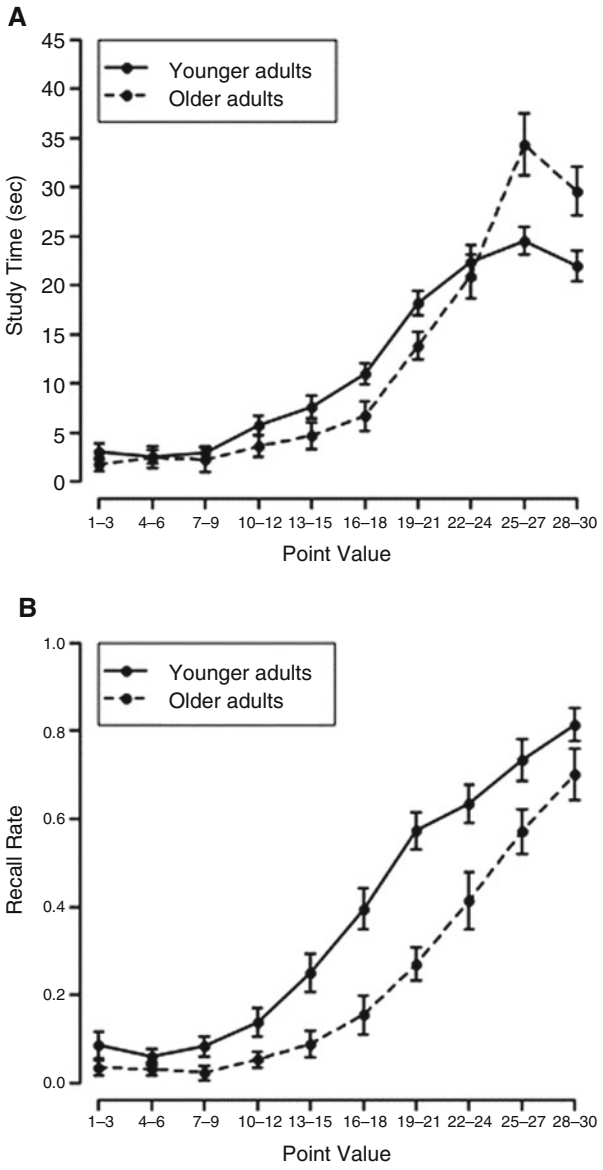

Fig. 12.2 Shows in A (top panel) the mean study time (in seconds), averaged across lists, as a function of binned point values for younger and older adults. B (bottom panel) shows the mean proportion recalled, averaged across lists, as a function of binned point values for younger and older adult. Copyright © 2013 by the American Psychological Association. Reproduced with permission. (Castel et al. 2013)

they might not be able to remember challenging, but important, information, then one either may not attempt to try to remember that information, or might instead turn to a more external strategy, such as writing it down (McDougall 1995).

The finding from Price et al. (2010) that older adults were somewhat less sensitive to value of information in their metacognitive control behaviors suggests that aging may detrimentally impact self-regulated learning strategies, at least under some conditions. Additional age-related deficits in study time allocation have been

observed by Tullis and Benjamin (2012). In their study, younger and older adults studied word pairs, and then were allowed to select half of the items for restudy. During restudy, participants either restudied the word pairs they had selected (honor condition) or those they had not selected (dishonor condition). It was found that younger individuals recalled more in the honor compared to dishonor condition, suggesting that they were fairly accurate in their assessment of which items warranted additional study. Older adults, however, recalled more word pairs in the dishonor condition, suggesting older adults may exhibit some age-related deficits in implementing effective study choices, even if their memory monitoring abilities remain intact.

Contrary to what was found by Tullis and Benjamin (2012), Li and colleagues (Li et al. 2018), utilizing a similar honor and dishonor procedure, found that both younger and older adults were more likely to recall information in honor condition (i.e., when they were allowed to restudy their selected choices). Importantly, Li et al. (2018) also examined the effect of point value on item restudy choice. In this study word pairs were associated with either 1 or 5 points. It was found that older adults were more likely to choose to restudy the 5-point value items, regardless of whether they felt these were well-learned items (i.e., had given higher or lower JOLs), whereas younger adults were more likely to restudy the 1-point items they felt were less well learned. This is further evidence suggesting that importance of material can have an impact on what older adults may choose to focus on, and that older adults may choose to selectively focus on higher value information, at the expense of less valuable information.

While there is some research on how value and importance impact metacognitive control operations, there are some inconsistencies in regards to what effect, if any, aging has on these processes. In general, the patterns of results suggest that older adults do strategically select and choose to focus on valuable or important information that leads to goal-relevant outcomes, and, at times, may demonstrate slightly more selectivity in their metacognitive control behaviors than do younger adults. In the real world, this would suggest that older adults may be more likely to attend to information they deem more important, but this could be at the expense of less important information.

12.4 Metacognition and Subjective Interest and Importance

While there is evidence suggesting that older adults are able to recall more objectively high value information, and metacognitive monitoring and control processes are also sensitive to objective value, it is often one's own interest or goals that determine the overall worth or "value" of information. Older adults, in particular, might place an even greater emphasis on remembering information they think is more important or valuable compared with information they are told is important. For example, it was found that older adults were better able to recall side effects of medications that they subjectively rated as more severe compared to those they

deemed milder, whereas younger adults recalled mild and severe side effects equally (Friedman et al. 2015).

Other studies have examined the influence of this more subjective measure of importance on memory in older and younger adults by manipulating personal relevance of the to-be-remembered information. For example, Hess et al. (2001) found that older adults were more accurate in their recollection of information related to a narrative describing an older target person (increased relevance) compared with one describing a younger target person; younger adults showed the opposite effect. Furthermore, older adults benefitted to a greater extent from increasing relevance than did younger adults. Germain and Hess (2007) found this pattern of better memory for more personally relevant information held true and also demonstrated that increased relevance was strongly associated not only with memory performance, but with more efficient processing (i.e., the ability to ignore irrelevant information). This suggests that interest or relevance of information can have an even larger positive effect on memory processes for older adults compared with younger adults, and that metacognitive monitoring and control processes might also be sensitive to degree of personal interest or importance.

The effect of subjective interest on memory has previously been examined in younger adults (Kang et al. 2009). Within this study, interest was defined as curiosity to learn unknown information. Curiosity is thought to be driven by an awareness of a gap between desired knowledge, and one's current level of understanding (Loewenstein 1994). Thus, in a sense, curiosity may be modulated by a combination of metacognitive appraisals of our level of knowledge and of our level of certainty in our ability to obtain that knowledge. Kang et al. (2009) presented younger adult participants with trivia question, and had participants rate how curious they were to learn the answer, after which participants were shown the answer. When given a later recall test, participants recalled more answers to the trivia questions that initially elicited higher levels of curiosity.

While previous studies have examined the impact of curiosity on memory for younger adults, there has been an increasing body of research examining the effects of curiosity on older adult's memory and metacognitive processes. One might suspect that if older adults are more selective about what information they attend to, then curiosity or interest could potentially be a larger predictor of memory performance, and may also have a greater influence on metacognitive monitoring judgments. Specifically, if one thought something was very important or interesting, then it is probable that one might also believe that information will be remembered, or perhaps even engage in additional strategies to try to effectively learn it.

McGillivray et al. (2015) examined the effect of initial curiosity to learn, and subjective interest on memory and metacognition in younger and older adults. In their study participants were presented with a large number of obscure trivia questions, and after being shown each question participants indicated their curiosity to learn the answer before they were shown the correct answer. After learning the answer, participants were asked to indicate how interesting they thought the answer was (post-answer interest) and also provided a judgment of learning (JOL) to indicate how well they thought they would be able to later remember that answer.

It was found that intrinsic post-answer interest was the largest predictor of later memory for the information for both younger and older adults. In addition, decreasing effects of interest from a short-delay to long-delay memory tests for younger adults were observed, but there were increasing predictive effects of interest on memory for older adults, suggesting interest may have increasing effects on memory for older adults with time.

McGillivray et al. (2015) also observed that both initial curiosity to learn answers, and to a larger extent, post-answer interest, predicted judgments of learning for both younger and older adults. This suggests that curiosity and interest are a cue that both younger and older adults may use when deciding what one is more or less likely to remember. New analysis of the data reported in this study examined JOL accuracy (using gamma correlations) for both high and low interest-eliciting questions for younger and older adults in order to determine if accuracy of metacognitive monitoring judgments is influenced by the subjective interest in the material. For each participant, the mean interest rating was calculated and the data were divided into high and low interest questions, and accuracy of the JOLs for these two categories of questions were examined. Among older adults, JOL accuracy was comparable for low-interest evoking questions ($G = 0.38$) and high interest evoking questions ($G = 0.34$). However, for younger adults JOL accuracy was better for low-interest evoking questions ($G = 0.58$) compared to high interest evoking questions ($G = 0.33$). While this could suggest that younger adults are better at monitoring their memory compared with older adults when they are less interested, these should be interpreted with some caution. It should be noted that the mean-split analysis resulted in a restricted range of scores, which could be obscuring the observed relationship between interest and accuracy of one's monitoring judgments. That being said, the ability to accurately monitor performance related to what one finds interesting seems to be relatively unaffected during later adulthood (Hargis et al. 2017; McGillivray et al. 2015).

In addition to the observed effects curiosity has on memory, it has been proposed that curiosity can serve many adaptive functions, particularly as individuals age (Sakaki et al. 2018). Specifically, prior studies have found that curiosity engages the dopaminergic system (Kang et al. 2009) and increases activity in the striatum, substantia nigra and ventral tegmental area (Gruber et al. 2014). In addition, factors such as novelty and uncertainty (which are likely associated with curiosity) may also activate noradrenergic systems (Devauges and Sara 1990; Gompf et al. 2010; Lavin et al. 2014). Sakaki et al. (2018) put forth evidence that suggest that curiosity's activation of the dopaminergic noradrenergic systems may have both direct and indirect effects on hippocampal, prefrontal cortex, and working memory function, as well as general feelings of well-being and health (see Fig. 12.3). The researchers also suggest that chronic activation of curiosity (i.e., trait curiosity) could lead one to engage in stimulating behaviors and activities that may protect against cognitive decline, as well as activate neurological circuits that could further expand upon the benefits that might be associated more momentary feelings of curiosity outlined in Fig. 12.3. Further, evidence of the benefits of curiosity, beyond just for the information that one might be curious about, were found by Galli and colleagues (Galli

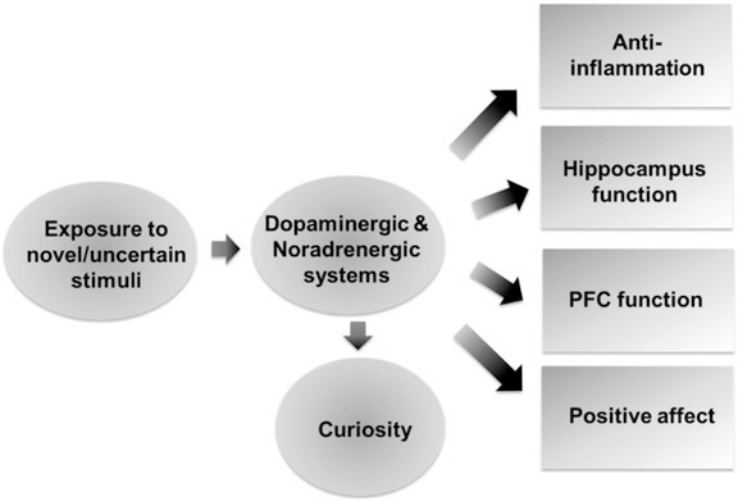

Fig. 12.3 Shows the proposed effects of feeling curiosity when exposed to something novel and/or uncertain. Reprinted from Neuroscience and Behavioral Reviews, Vol. 88, Sakaki, Yagi, and Murayama, Curiosity in old age: A possible key to achieving adaptive aging, p. 109, © 2018, with permission from Elsevier. (Sakaki et al. 2018)

et al. 2018). In this study, older and younger adult participants were shown trivia questions and indicated their level of curiosity to find out the answer.

In addition, task-irrelevant faces were shown after participants saw each question, but before they were shown the answer to the question. It was found that both younger and older adults were more likely to recall answers to trivia questions they were more curious about, and were also more likely to correctly recognize faces presented with the questions that had elicited higher levels of curiosity. These finding offer additional support for the potentially expansive benefits that feelings of curiosity may elicit, at least in memory-related domains.

In summary, as individuals age, factors such as subjective interest or curiosity could have an even larger effect on memory. In addition to interests' impact on memory, subjective feelings of interest may also impact metacognitive monitoring judgments, although it is unclear how they may impact metamemory control behaviors. It is likely that interest might serve to rally and direct attentional resources or lead one to engage in more elaborative encoding, which in turn benefits long-term memory and could also benefit strategic metacognitive control operations. Importantly, a person's interests can be linked with satisfaction in life, and thus a better understanding of how, precisely interest impacts cognitive operations is warranted.

12.5 Metacognitive Monitoring and Emotional Material

A common finding in emotion and memory literature is that individuals, of all ages, are somewhat more likely to (although not always, see Dougal and Rotello 2007) better remember emotional information compared to neutral information (e.g., Murphy and Isaacowitz 2008). This finding is consistent with most people's subjective everyday experiences, in that seems like we are just more likely to notice and remember something if it elicits an emotional reaction from us. While there is a wealth of literature on emotions' effect on memory, there are decidedly fewer examinations into emotional materials' effect on metacognitive judgments, and this research has mostly been conducted with only younger adults (for a review of how emotion impacts metamemory see Efklides 2016).

Zimmerman and Kelley (2010) found that younger adults' JOLs were higher for positive and negative words compared to neutral words, and participants were more likely to freely recall emotional words compared to neutral words. However, on a cued recall test, only the positive words were remembered better, despite high JOLs for both negative and positive information. Other studies with younger adults utilizing positive and neutral pictures (Hourihan and Bursey 2017) and neutral and negative faces (Witherby and Tauber 2018 Experiment 1) have found that participants' JOLs, but not memory, for emotional materials were higher. This suggests that emotional content may be a strong cue that individuals rely on when forming their metacognitive judgements, but this cue may be, at times, misleading when it comes to accuracy of these judgments.

Before discussing the few research studies on metacognition, emotion, and aging, it is important to note some of the age-related differences in standard memory tasks for emotional materials. For example, there have been a number of studies that have found a positivity bias in older adults' memories (but see Fernandes et al. 2008). The positivity bias refers to the finding that older adults seem to be more likely to remember positive compared to negative information (Carstensen and Mikels 2005; Charles et al. 2003; Mather and Carstensen 2005; Schlagman et al. 2006). Interestingly, it has been suggested that this positivity bias may be the result of older adults' chronically-activated goal to maintain a positive emotional state (Mather and Knight 2005). That is, older adults to some extent may choose to attend to positive information, and perhaps even work to down-regulate negative information. An important question, as it relates to metacognition, is whether this goal to attend to and remember more positive information is more implicit or explicit in nature. If a positivity effect exists in older adults' memories, will conscious, explicit metacognitive judgements of emotional materials reflect this?

Across two experiments Tauber and Dunlosky (2012) investigated both younger and older adults' metacognitive accuracy for emotional words. Using a similar paradigm as Zimmerman and Kelley (2010), participants were shown positive (e.g., bunny, diamond), negative (e.g., assault, bomb), and neutral (e.g., fabric, cork) words. Immediately after each word participants were asked to provide a JOL from 0% (certain the words would not be recalled) to 100% (certain the word

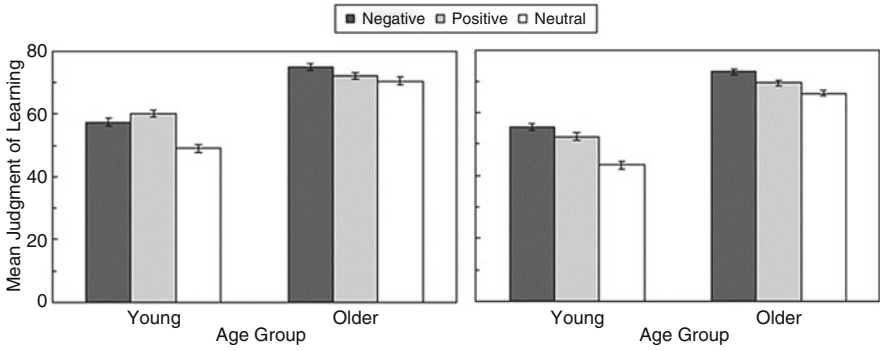

Fig. 12.4 Shows the average judgment of learning (JOL) for positive, negative, and neutral word type from Experiment 1 (left panel) and Experiment 2 (right panel). Error bars are standard errors of the mean. Copyright © 2012 by the American Psychological Association. Reproduced with permission. Tauber and Dunlosky (2012)

would be recalled). After this the participants were asked to freely recall as many words as they could. As is shown in Fig. 12.4, Tauber and Dunlosky (2012) found that younger adults' JOLs were higher for both positive and negative words compared to neutral words, but older adults only gave higher JOLs to negative, but not positive, words compared to neutral words. Furthermore, both age groups recalled more positive and negative words compared to neutral words, but did not recall more negative compared to positive words. In regards to the accuracy of metacognitive judgments, the researchers examined whether higher JOLs were given to information later recalled, and lower JOLs to information not recalled (i.e., relative accuracy using gamma correlations). The results across the two experiments were somewhat mixed, but indicated that both younger and older adults' judgments were relatively accurate in predicting recall of negative information, but that older adults were in fact less accurate in their predictions of their ability to recall positive information. Although overall accuracy of judgments did not differ significantly for emotional compared to neutral information. This suggests that the ability to accurate judge what one is likely to recall may not be affected by the emotional content of the information.

The results of this study are somewhat puzzling as they run counter to the literature that has found a positivity bias in older adults' memories. If anything, Tauber and Dunlosky (2012) found that older adults displayed more of a negativity bias in both their JOLs and recall. While older and younger adults' metacognitive monitoring judgments were somewhat sensitive to the effects of emotion, older adults' judgments were in fact less sensitive to the effects of positive emotions. Mather and Knight (2005) suggested that the positivity bias may, in part, be due to a chronically activated goal to maintain a positive emotional state.

While older adults did recall more positive (and negative) compared to neutral information, this pattern did not seem to be captured in their JOLs. This could indicate that if a positivity goal exists, it may at times operate on a more implicit level

that does not affect older adults' explicit judgments. It could also be the case that the need to provide a JOL became a more salient than the goal to maintain a positive emotional state. Mather and Knight (2005) found that older adults under divided attention do not exhibit a positivity bias in memory, and it has also been suggested that asking individuals to provide judgments may actually alter memory performance (Mitchum et al. 2016). Another possibility that Tauber and Dunlosky (2012) proposed is that the materials (i.e., words) may not be as emotionally salient as materials used in other emotional memory paradigms (e.g., pictures). Thus, if an individual experienced less of an emotional reaction to some of the material, and perhaps in particular the positive material, there may be no reason to suspect that judgments or memory performance would be impacted.

In order to examine older adults' metamemory monitoring for more emotionally arousing information, Tauber and colleagues (Tauber et al. 2017) presented younger and older adults with positive and neutral images. It has been suggested that pictures may be more likely to elicit emotional responses than single words (Kensinger and Schacter 2006). Importantly, the emotional intensity of the images varied and were either classified as positive and high arousal (e.g., skydiving), positive and low arousal (e.g., fishing), neutral and high arousal (e.g., lava) or neutral and low arousal (e.g., a rock formation; Tauber et al. 2017). As participants studied each picture, they provided a JOL from 0 to 100. After a short delay, participants took part in a free recall test in which they had to describe the images they remembered. It was found that both younger and older adults' JOLs were higher for both high and low arousal positive images compared to high and low arousal neutral images, but JOLs did not seem to differentiate between high and low arousal positive images. A similar pattern was observed with older and younger adults' recall performance, with both younger and older adults remembering more positive images, regardless of arousal level, compared to neutral images. Lastly, the accuracy of metacognitive judgments appeared to be unaffected by image type, arousal level, or age.

The findings from Tauber and colleagues (2012, 2017) suggest that older adults are, in fact, effectively able to monitor their encoding of positive emotional information, provided the material contains richer emotional cues. Put simply, age does not seem to negatively impact one's ability to realize that positive information is more likely to be remembered than neutral information. Furthermore, it suggests that emotion can, at times, be a salient cue that both younger and older adults use to form memory judgements, although these cues might be misleading at times, particularly when it comes to correctly recognizing emotional material (see Comblain et al. 2004; Kapucu et al. 2008). However, Tauber and colleagues (2012, 2017) found that the ability to accurately monitor positive information does not appear to be any better than the ability to monitor neutral information (i.e., measures of resolution were similar for emotional and neutral information). What this indicates is that emotional content neither enhances nor diminishes one's ability to judge what is more or less likely to be recalled. What is still unclear though is whether metamemory judgments would be impacted when both positive and negative emotion-inducing material is present. As was previously mentioned, most of the studies that have found a positivity bias in older adults' memories have used positive and negative images.

To date no studies have utilized similar materials to study older adult metacognitive monitoring judgments, and this is an important area for future research.

12.6 Summary and Future Directions

Declines in cognitive functioning have been well documented in aging literature. While, of course, it is vital to understand the limitations older individuals may face, and potential causes of deficits, it is equally as important to fully explore and understand the constellation of factors that mitigate deficits and speak to older individuals' ability to maintain a high quality of life and healthy functioning. The findings of intact metacognitive functioning in many studies suggest that insight into, and understanding of one's memory capabilities is not negatively impacted during the aging process, or at least is impacted to a lesser extent than other cognitive functions.

A central and perhaps quite critical memory-related goal in many individual's lives, and perhaps particularly older adults, is to be able to remember information that is important (either subjectively or objectively) information one is interested in, or more emotional-relevant information. Evidence suggests that that the mechanisms that lead one to be able to recall more important or interesting information are intact during the aging process, and interest, prior knowledge, and the emotional content of the material may mitigate some of typically observed age-related decrements in memory processes.

While there is a growing body of evidence that suggests factors such as emotion, motivation, interest, and prior knowledge impact memory, there is still relatively little research on how these impact metacognitive monitoring and control during older adulthood. Some of the studies discussed in this chapter suggest that older adults are able to strategically monitor and control memory processes, and that metamemory judgments are sensitive to subjective interest and emotional content, but many questions remain unanswered. For example, do older and younger adults differ in regards to metacognitive control processes (e.g., item selection or strategy usage) when learning emotional or "interesting" material? Are older adults more likely to implement strategic control behaviors or mnemonic strategies when motivated to learn either valuable or interesting information? Additional research into the impact that interest, emotions, motivation, and prior knowledge have on metamemory monitoring and control is warranted and could further inform and improve theories of cognitive aging, and well as theories of learning and memory more generally.

In addition, this relative sparing of metacognitive abilities, in light of some deficits in explicit memory abilities, suggests that older adults may be able to use metacognitive strategies or awareness to help overcome or compensate for age-related declines in memory performance. In fact, it has been suggested that training metamemory monitoring and control could serve to better inform or perhaps be even more beneficial than general memory training strategies for older adults

(Hertzog and Dunlosky 2011; see also Bampa et al., Chap. 13 this volume). For example, Troyer (2001) found that educating older individuals how memory works as well as memory strategies increased older adults' knowledge of and satisfaction with their memory, as well their memory functioning on everyday task. This line of research has implications not only for memory training programs, but also speaks to older adults' ability to maintain healthy cognitive functioning in everyday life.

In conclusion, there are numerous factors, including but not limited to value, emotion, and importance, that have the capacity to moderate one's memory and metacognitive judgments. It is crucial to fully explore and understand the relationships between these various memory-moderating factors as well as the degree to which they affect metamemory, particularly for older adults. Older adulthood is often accompanied by a number of major life-decisions in areas such as health care, retirement, and financial planning. Making effective decisions often requires learning new information, being aware of one's knowledge level, and ultimately prioritizing and organizing that information. Once the factors and mechanisms supporting the facilitation of memory, as well as metamemory monitoring and control are better understood and fully explored, they could serve to assist fields such as information dissemination in a way that assists learning, prioritization and enhances quality of everyday functioning for older adults.

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